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MONTHLY WEATHER REVIEW

NOVEMBER 1933

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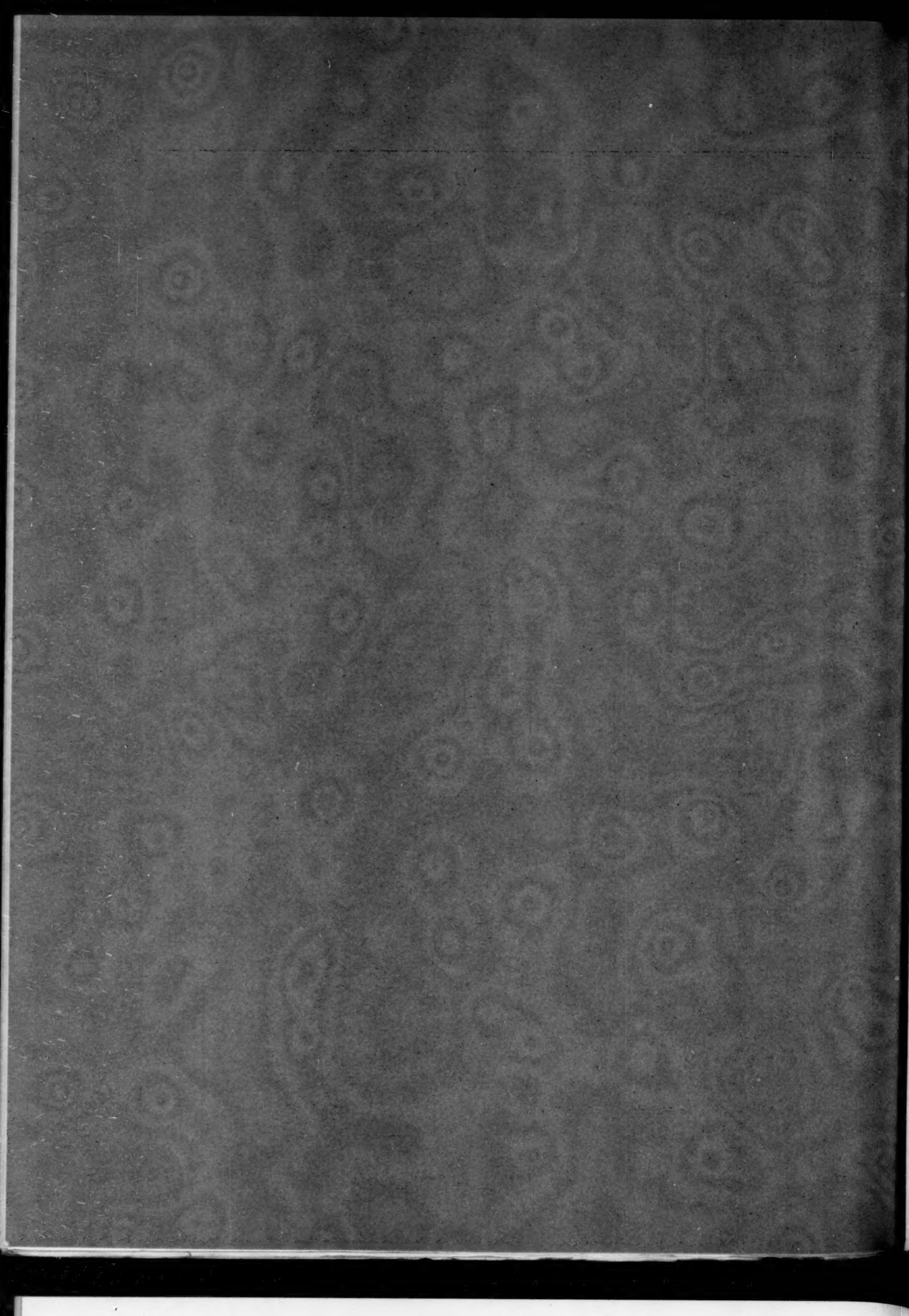

MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

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NOVEMBER 1933

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THE NORTH AMERICAN HIGH-LEVEL ANTICYCLONE

By THOMAS R. REED

[Weather Bureau, San Francisco, Calif., November 1933]

The existence of an anticyclonic system of air circulation at high levels over the southwestern portion of the North American Continent during the warm season is one of the most interesting and important revelations yielded by aerological investigations in the United States. Prior to these investigations such a thing was unsuspected, at least in the form in which it is now regularly observed, although ample theoretical grounds existed for assuming that it was there. Since the inauguration of daily pilot-balloon runs in the Far Western States, however, information has accumulated about this high-level anticyclone until today forecasters in the Far West look upon it as one of the distinctive and influential meteorological features of their domain.

Before 1921, when the first regular pilot-balloon work was undertaken on the Pacific coast, it was commonly supposed that a sort of monsoonal wind circulation existed over California and the neighboring ocean in summer. The observed westerly winds from the sea were supposed to be warmed over the land, to rise and return to sea at higher levels. In other words, a west wind at the surface presupposed a return east wind aloft. This assumption was considered sound enough at one time to incorporate in a manual of instructions for Marine Observers, but balloon runs which were begun in San Francisco in 1921 failed signally to reveal east winds aloft except on rare occasions; rather they showed the upper winds to be usually from some southerly quarter in summer. Since moving air (in the Northern Hamisphere) has high pressure on its right the problem was presented of a barometric gradient at high levels *sloping upward over the Nevada Plateau*, a region where low pressure is a normal summer condition at the surface of the earth.

It was not until some years later, not, in fact, until a wide network of upper-air stations had been installed in the southwestern United States in connection with the elaborate airways weather service begun by the Government in 1928, that this phenomenon and its cause were fully evident. Then sufficient free-air data soon became available for plotting the wind circulation at high levels daily throughout a large part of the Pacific Southwest, and from these plots the habitual anticyclonic or clockwise circulation at high levels became clearly evident. Winds aloft over southern New Mexico and southern Arizona often were observed to be from the east; over southern California from the south or southeast; over northern California from the south or southwest, and over northern portions of the Great Basin from the west or northwest. Noting this situation one day, when the condition was extremely obvious, my colleague, Maj. E. H. Bowie, epitomized it as "a perfect example of Ferrel's high-level anticyclone". Certainly Ferrel has described it, but equally certainly he never expected to see his description vindicated in such a way. Reference to his "Popular Treatise on Winds" (pp. 258–261) will make this clear. Both his text and diagram presuppose an anticyclonic circulation superposed on a cyclonic: Outflowing clockwise winds aloft over inflowing counterclockwise winds below. In the lower levels the isobarometric surfaces were assumed to be concave, in the upper levels, convex.

While such conditions have not been found in dynamically-caused depressions, for reasons which are now familiar to everyone, they are characteristic of the thermally induced depression of the summer season over the southwestern United States. Particularly is this true of the convexity of the upper isobarometric surfaces and of the uniformity of the attendant clockwise circulation around them. In 1928 when this regime of wind and pressure first became apparent, it was brought before the meeting of the American Meteorological Society at Claremont, Calif., by Bowie, where it aroused considerable interest and was briefly discussed. A year later he referred to it in an article published in the MONTHLY WEATHER REVIEW,[1] wherein he explained the nature and cause of the reversed gradient aloft, using two California stations for illustration, one located in the hot interior and the other on the coast. In the following year (1930) still more aerological stations were added to the observational net and the results of the daily pilot-balloon runs were made universally available by publication regularly in the MONTHLY WEATHER REVIEW of "resultant" upper-wind data for the entire United States. By means of these data it became possible to plot resultant winds for monthly periods over a very large area and for a number of different levels from the surface up to 5,000 m altitude, and the consequence of such charting has been to still further elucidate the anticyclonic regime aloft and to understand better its nature and effects. The salient features thus revealed, considered topically, are as follows:

Period.—The anticyclone, being distinctly a warm-season phenomenon, makes its first appearance in the spring, but it does not become fully established until midsummer. It reaches its maximum development in July and August, and disappears, except for sporadic recurrences, in October.

Height.—This is a variable factor and is dependent in some degree on the height and configuration of the land masses beneath. The anticyclonic circulation is not apparent as a whole below the 10,000-foot level (above mean sea level) since the disturbing element of mountain peaks and ridges thereunder prevents conformity to the gradient wind ideal. It is developed almost without hindrance at

[1] MONTHLY WEATHER REVIEW, 1929, vol. 57, pp. 332–334.

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the 14,000-foot level. No free-air observations are available between that height and 20,000 feet, but charts drawn for the 20,000-foot level (the maximum height for which the balloon runs are reported) show its existance there and imply that it extends upward as far as the tropopause.

Location.—(Charts 1 to 12.) The controlling factors being surface temperature and a latitudinal position somewhere between the northeast trades and the westerlies of higher latitudes, the anticyclone is necessarily confined to the southern United States and northern Mexico, but within these limits it is quite mobile and its crest moves through a very considerable range of latitude and longitude. With only 3 years' observations to draw upon, it would be premature to assume a mean position, but from study of the available resultant wind data it seems reasonable to suppose that in normal years the crest often will be found over or east of the southern Rocky Mountains; that is to say, over Texas or New Mexico. However, this surmise applies only to the months when it is at its height, viz, July and August. It is ventured for the reason that July and August are preeminently the months of so-called "Arizona type" rains, and rains of this type are so evidently associated with the western quadrants of the anticyclone that they presuppose the position of its crest to be usually somewhere to the eastward in these months. Its mean monthly positions for the 3 seasons 1930–32, have been as follows: May, over northern Mexico; June, the same but encroaching on the southern border States; July, twice over the west Gulf States and once over Arizona; August, once over New Mexico, once over Arizona, and once over the west Gulf States; September, once over Arizona and twice over northern Mexico. References to its Mexican position are necessarily vague, as no upper-wind data are available from that country.

Relation to surface temperature.—It has been said that within limits its position is quite variable, the crest being sometimes west of the Continental Divide and sometimes east of it; sometimes north of the Mexican border and sometimes south of it. It appears first over Mexico and moves northward as the season advances, retreating to Mexico as the warm season wanes. The controlling factor, or at least a dominant influence, mean positions considered, seems to be surface temperature. Reference to individual months is of interest in this connection and bears out the inference. For example, during the memorably hot month of July 1930 (east of the Rockies), the mean position of the crest was over the west Gulf States, while in July 1931 when temperatures were considerably above normal over the far Southwest, its mean central position was over northern Arizona. Again in July and August 1932, with temperatures above normal in the Cotton Belt, the center was again over the west Gulf States, or thereabouts. Of unusual significance in this connection is the mean position of the anticyclone in September 1931. Temperatures in that month averaged as much as 8° F. above normal in the southern Plains States and Oklahoma, and so, notwithstanding the lateness of the season, an anticyclonic air circulation is plainly apparent on the wind-aloft chart over all the far Southwest, including Texas, Oklahoma, and Colorado. The crest of the anticyclone appeared to be over northwestern Mexico with the main axis pointing toward the northeast.

Effects.—The study of this anticyclone is of more than academic interest as it exerts a profound effect on the weather of the southwestern United States, and perhaps of an even greater area. It is associated with the remarkable atmospheric stability that gives California its characteristically dry summers, and with the atmospheric instability that is responsible for summer rains of the "Arizona type", a short distance eastward.

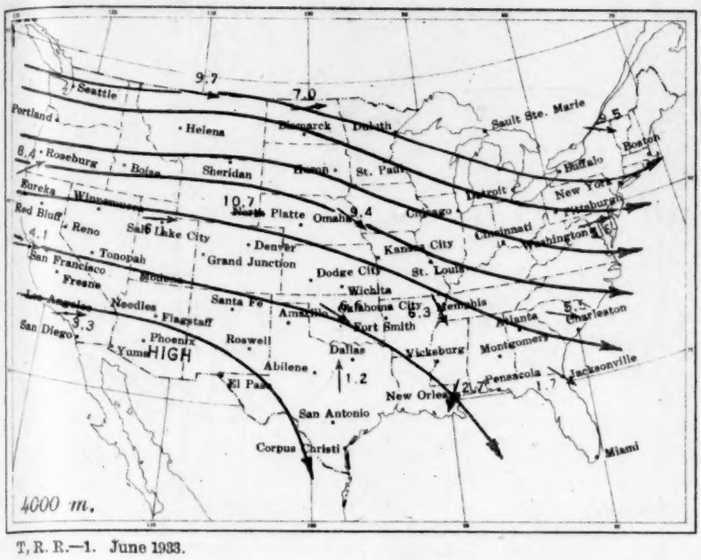
The first inquiry of the weather-minded newcomer to California is "Why no summer thunderstorms?" And the answer is: "The air is too warm aloft". Penetrative convection is only possible on rare occasions, notwithstanding that California surface temperatures must initiate as vigorous convection in the dry season as is to be found anywhere in the United States. But ascensional currents cannot be perpetuated to the point of condensation as they soon reach levels where air of higher temperature and hence of less density is encountered. This condition of stability is characteristic not alone of California in the warm season; but the rainless régime is subject to fewer interruptions in that State and Lower California than anywhere else. The reason for this stability, as has been said, is the warmth of the air aloft, and the source of this warm air is the high-level anticyclone around which it is circulating.[2]

If the same fountain does not send forth both sweet waters and bitter, we may ask with incredulity why the air circulating around the high-level anticyclone produces such opposite effects—stability on the one hand and instability on the other—"Arizona rains" on the east and California drought on the west. Looking at charts of summer-rainfall frequency percentages we are impressed by the marked preponderance of summer rains from central Arizona eastward, while to the westward their frequency falls off with conspicuous abruptness. In fact, the summer season is distinctly the wet season for one district and distinctly the dry season for the other. Alexander's thunderstorm chart[3] is even more impressive. For the 10-year period 1904–13, it shows a maximum (west of the 90th meridian) of 732 thunderstorm days at Santa Fe, N.Mex., which declines westward to less than 100 in California and a minimum of 10 at San Francisco. This situation is not peculiar to the southwestern United States only, but is integral with the climate of northern Mexico. In fact the rainfall "provinces" of northern Mexico fit exactly with our own rainfall provinces across the border and suggest that the explanation of one will satisfy the conditions of the other. We see that the region contiguous to southeastern Arizona and New Mexico is one of summer rainfall maxima, while immediately to the westward is found the California type, of almost rainless summers and the most extreme aridity in all Mexico. We cannot fail to remark that the dividing line between these two rainfall provinces is the mountain escarpment that fringes the western edge of the Mexican Plateau. This observation is most important because it suggests the explanation we are seeking (partial, at least) for the singular contrast in free-air temperatures over California on the one hand and over the Arizona "rainfall province" on the other.

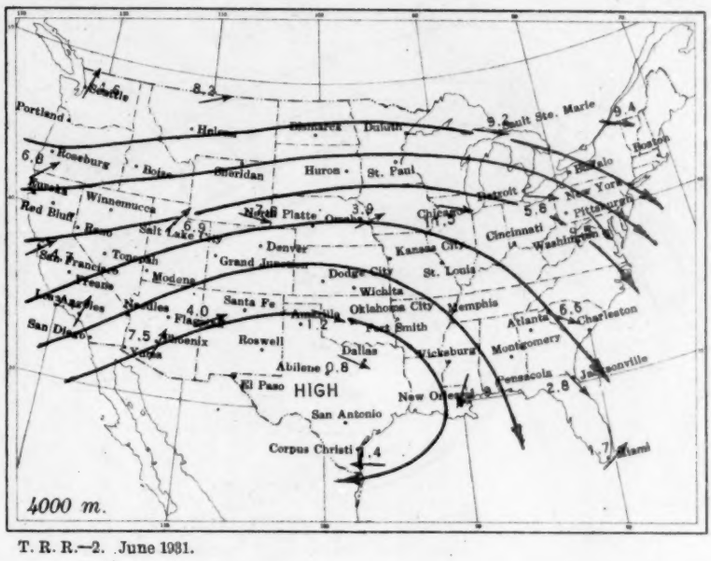
Let us suppose the high-level anticyclone to be centered, where it so often is in the summer, over Texas or New Mexico. This is the season of instability rains over the whole region to the east and south of it, i.e., from the Gulf States to southern Mexico, so we do not have to

[2] It is also true that California's rainless summers are attributable, in part, as Dr. Humphreys has pointed out in his "Physics of the Air" (1st edition), p. 302, to the fact that the temperature of the on-shore winds is too low and their humidity too small to permit penetrative convection, but this is only true because of the characteristic lapse rate over this region. Actually, there is much more water vapor present in California's atmosphere than in New Mexico's. At Santa Fe, N.Mex., with the greatest thunderstorm frequency of any place in the United States west of the 90th meridian, the mean absolute humidity (grs.) June, July, and August, is 2.94 at 8 a.m. and 2.62 at 8 p.m., while for California, with one tenth the thunderstorm frequency, the values are as follows: Sacramento, 4.18 and 5.31, respectively; Eureka, 4.14 and 4.27; San Francisco, 4.27 and 4.37; San Diego, 5.37 and 5.82. Yuma, Ariz., on the California line, in the hottest and most arid region on the continent, has a higher absolute humidity in summer than any station in New Mexico, and but little lower than many in Texas.

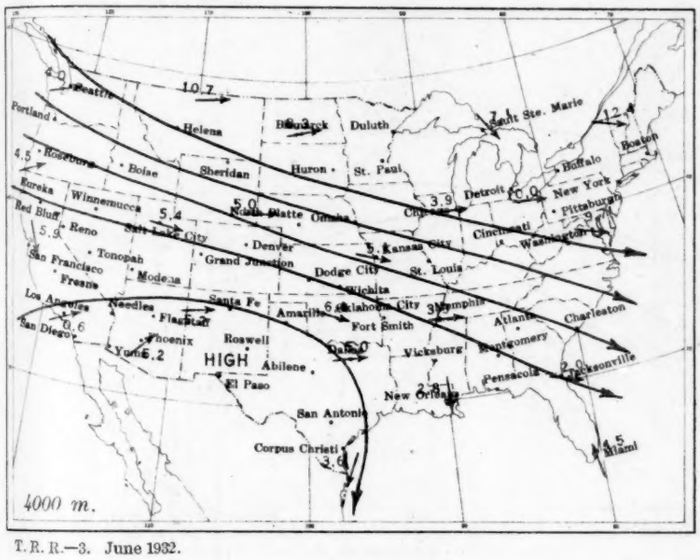
[3] MONTHLY WEATHER REVIEW, July 1915.



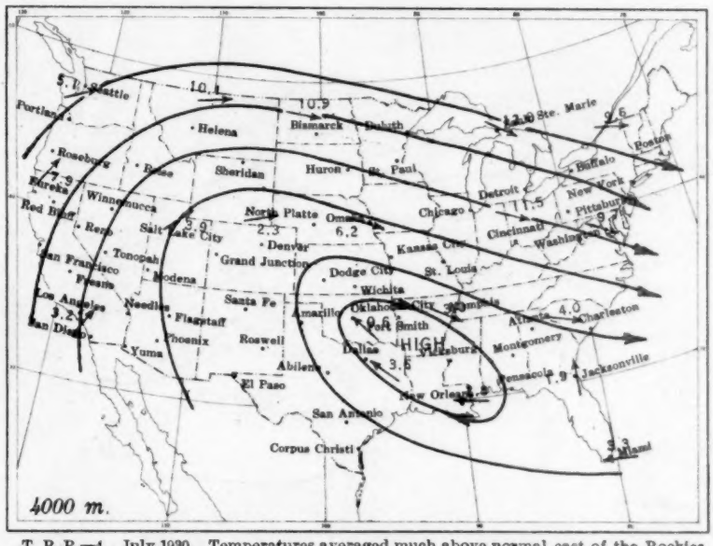
T, R. R.—1. June 1933.



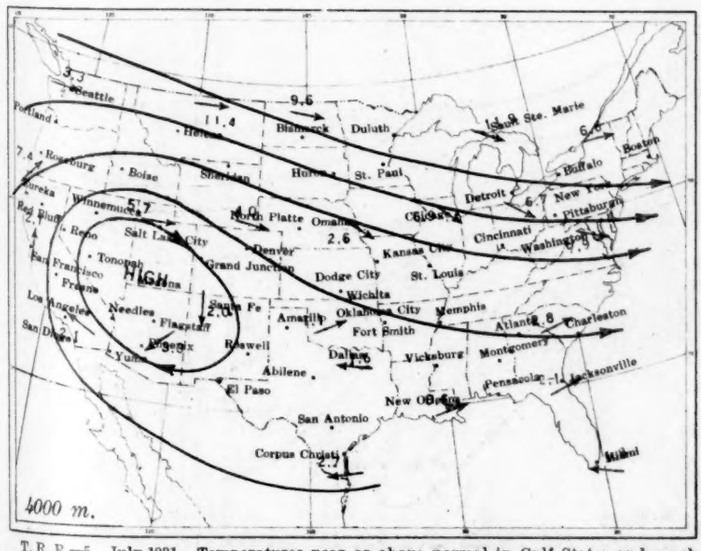
T. R. R.—2. June 1931.



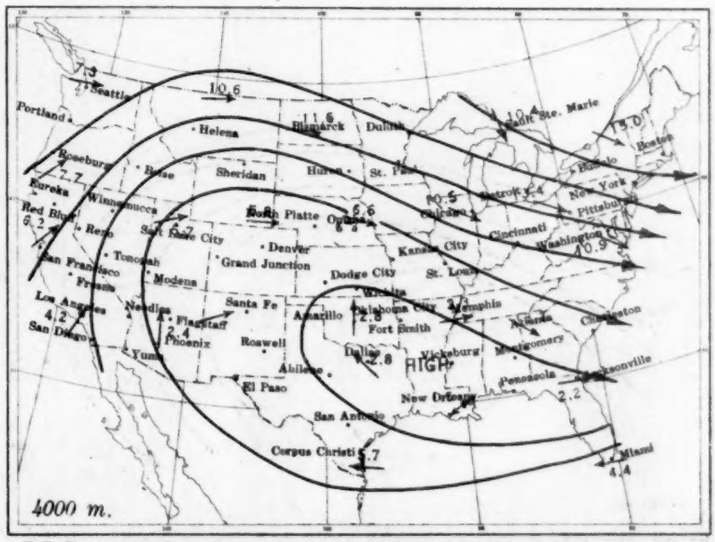
T. R. R.—3. June 1932.



T. R. R.—4. July 1930. Temperatures averaged much above normal east of the Rockies, while west of them they were about normal. Hence the high-level anticyclone is centered over the Southern States east of the Continental Divide.



T. R. R.—5. July 1931. Temperatures near or above normal in Gulf States and much above normal over the far Southwest. Anticyclone centered west of the Continental Divide.



T. R. R.—6. July 1932. Temperatures well above normal in Middle West and South and below normal in California.

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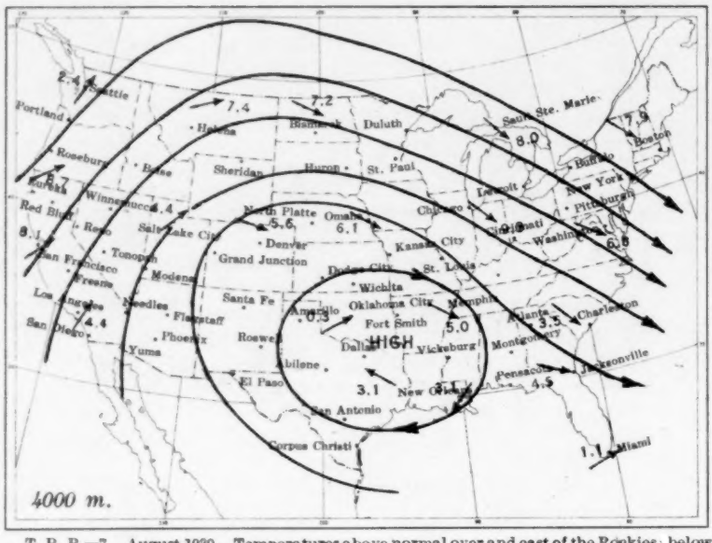
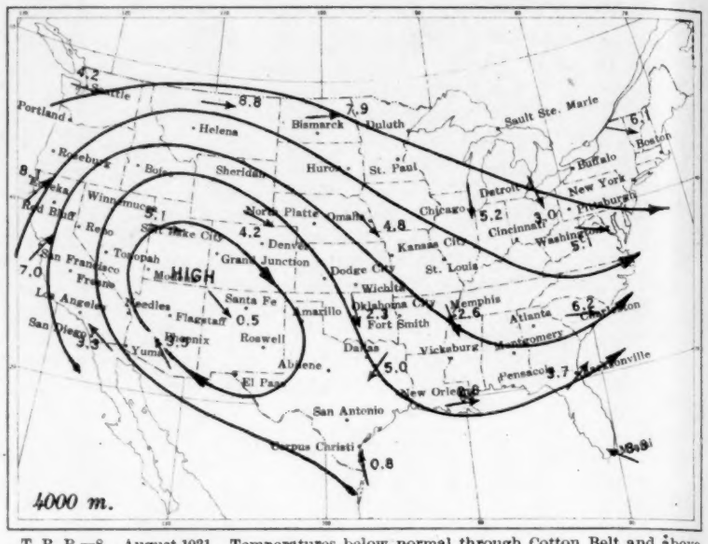
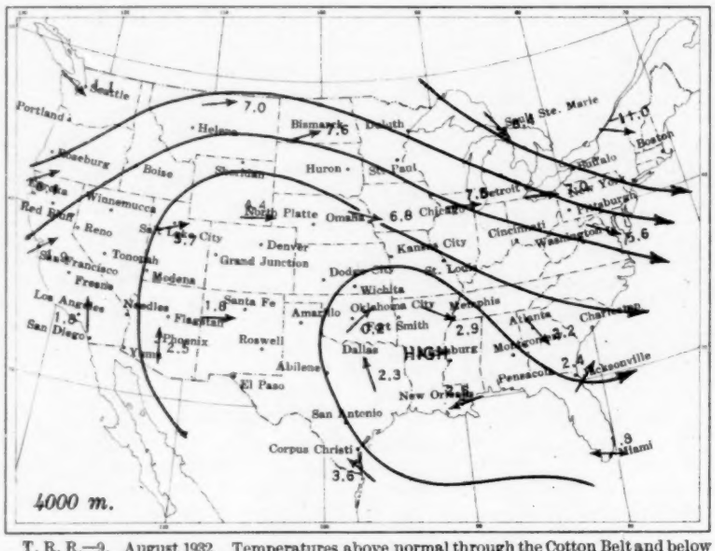


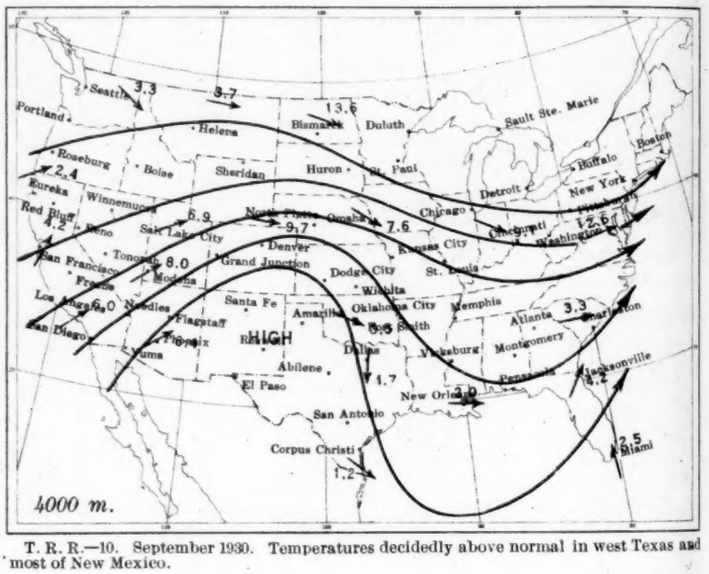
T. R. R.—7. August 1930. Temperatures above normal over and east of the Rockies; below normal to the westward.



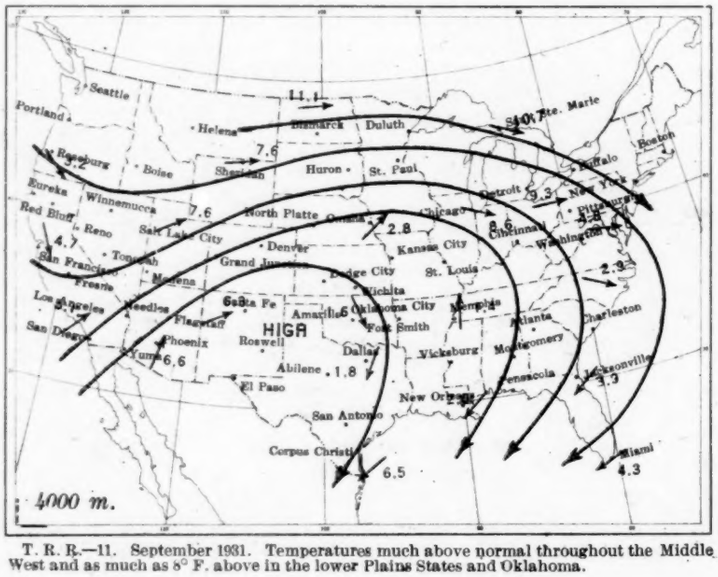
T. R. R.—8. August 1931. Temperatures below normal through Cotton Belt and above normal west of the Continental Divide.



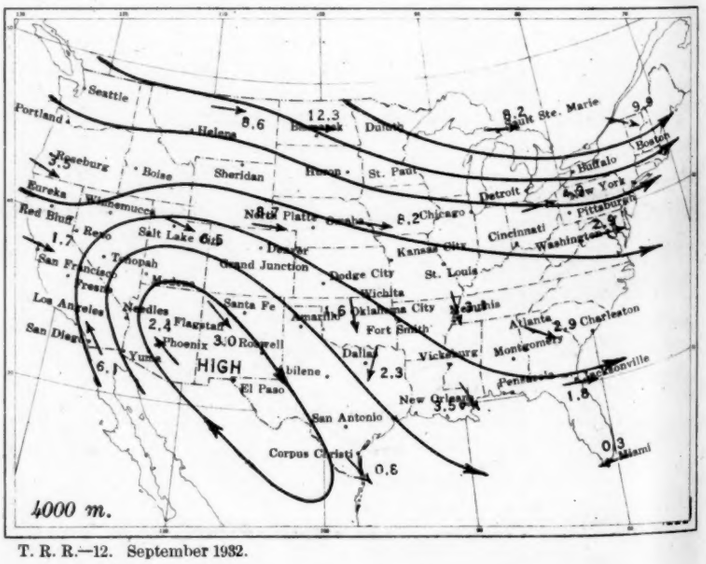
T. R. R.—9. August 1932. Temperatures above normal through the Cotton Belt and below in central and southern California.



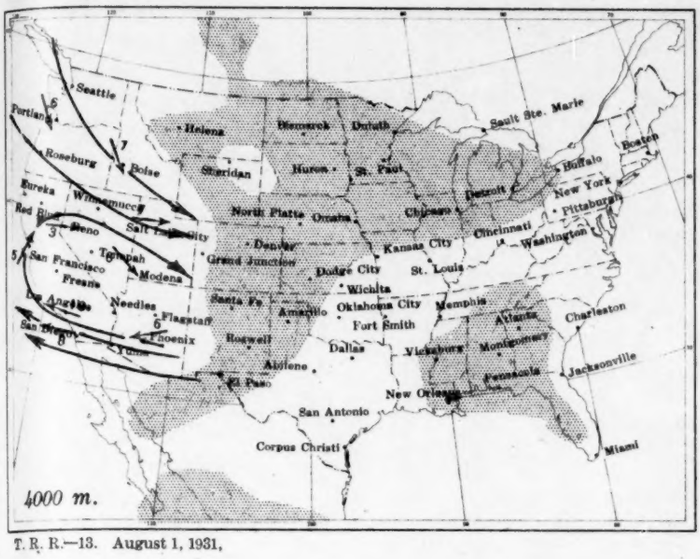
T. R. R.—10. September 1930. Temperatures decidedly above normal in west Texas and most of New Mexico.



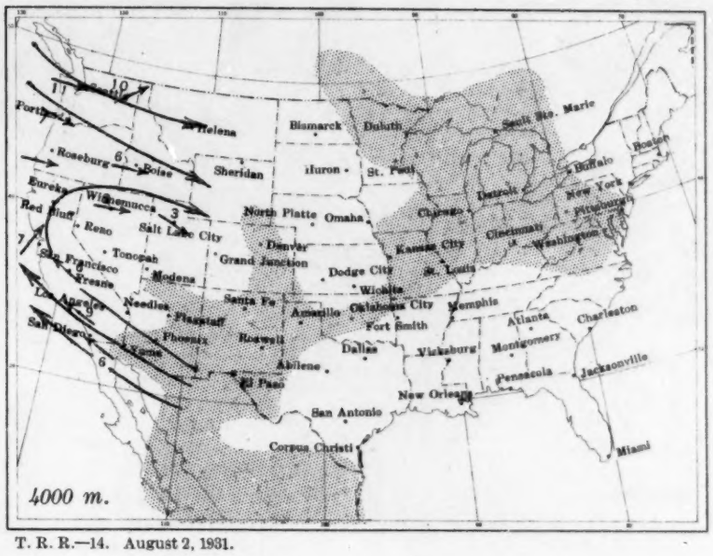
T. R. R.—11. September 1931. Temperatures much above normal throughout the Middle West and as much as 8° F. above in the lower Plains States and Oklahoma.



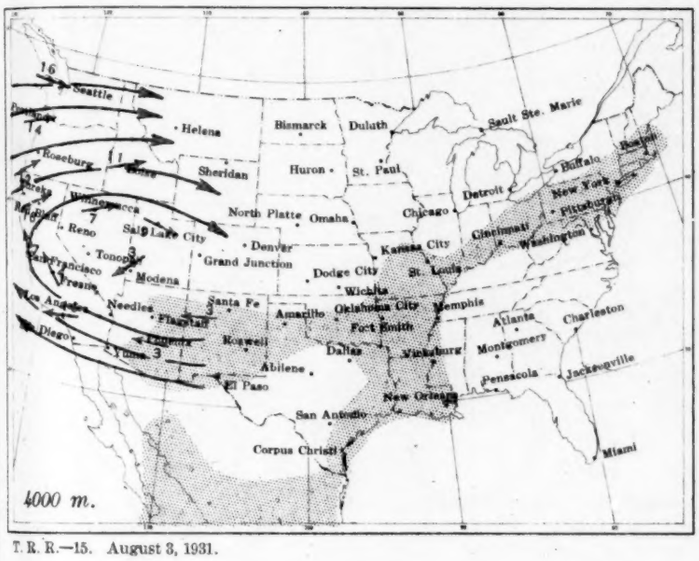
T. R. R.—12. September 1932.



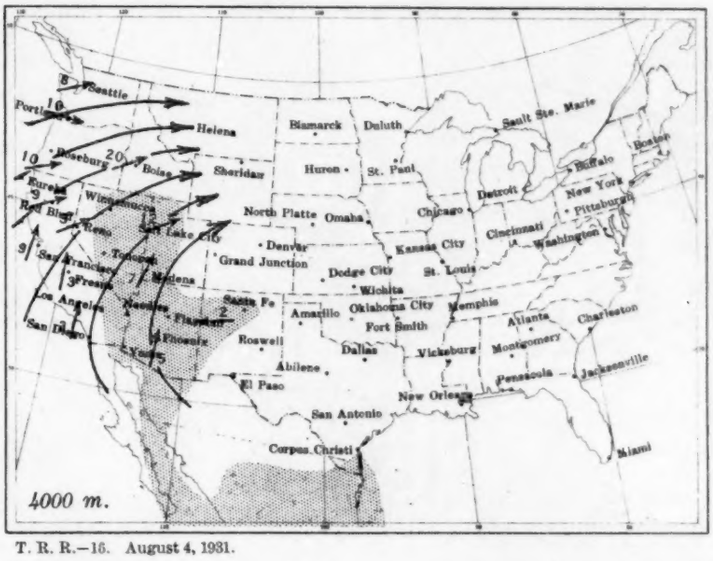
T. R. R.—13. August 1, 1931,



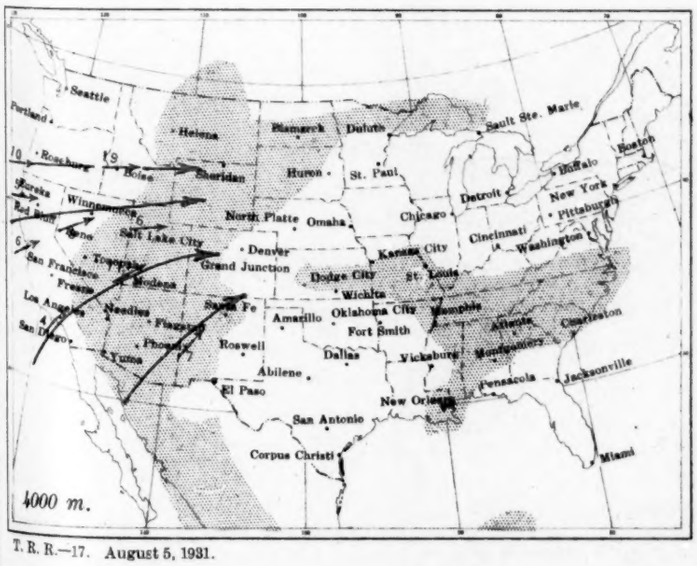
T. R. R.—14. August 2, 1931.



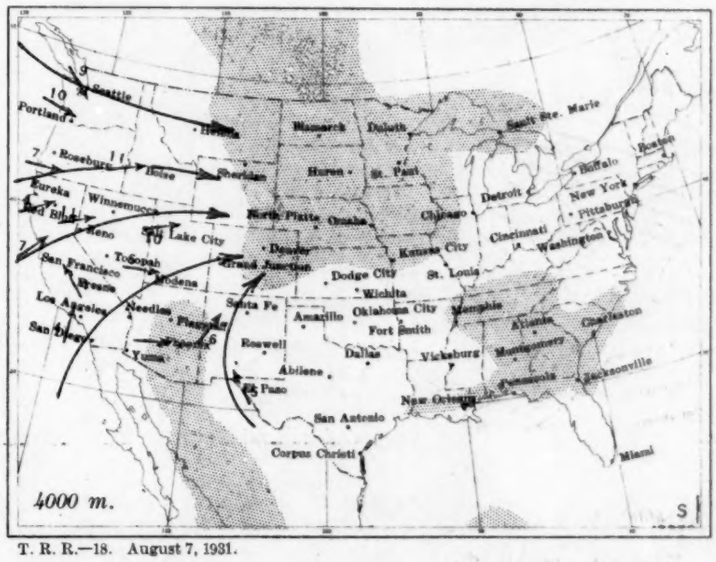
T. R. R.—15. August 3, 1931.



T. R. R.—16. August 4, 1931.



T. R. R.—17. August 5, 1931.



T. R. R.—18. August 7, 1931.

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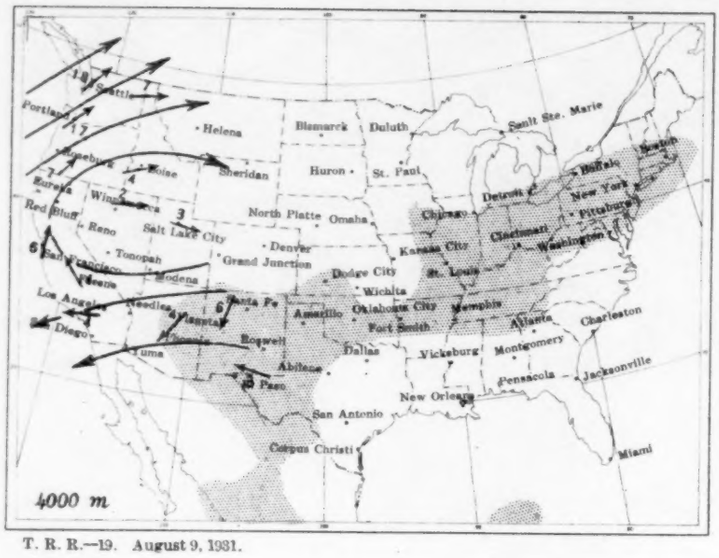
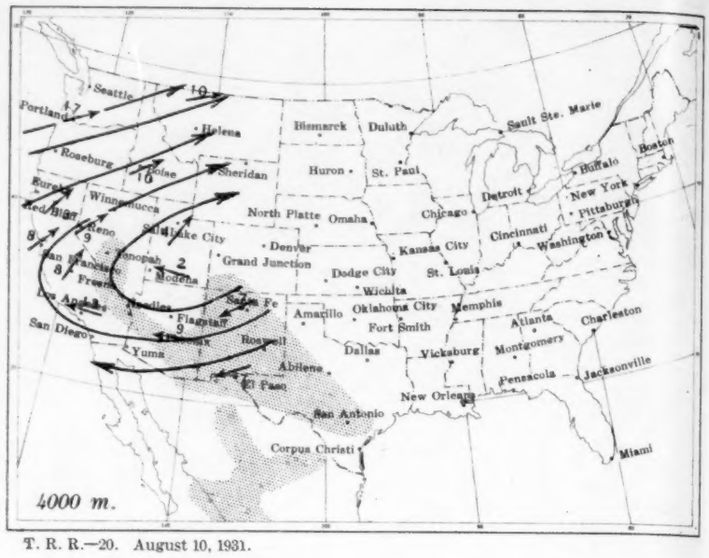
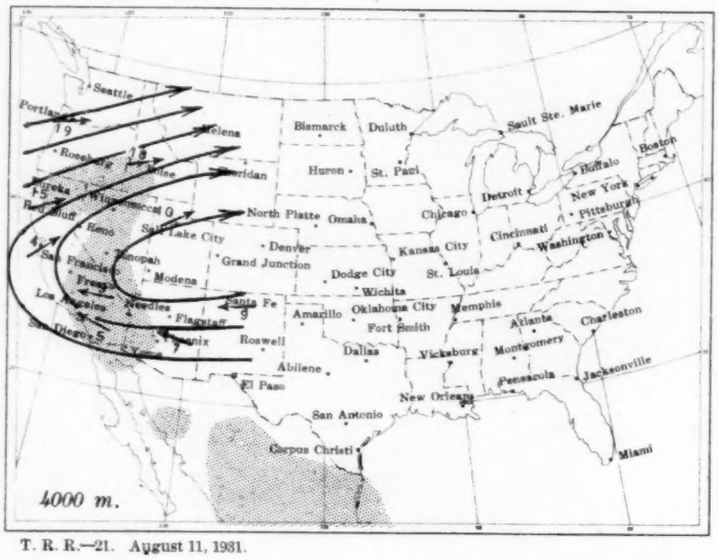


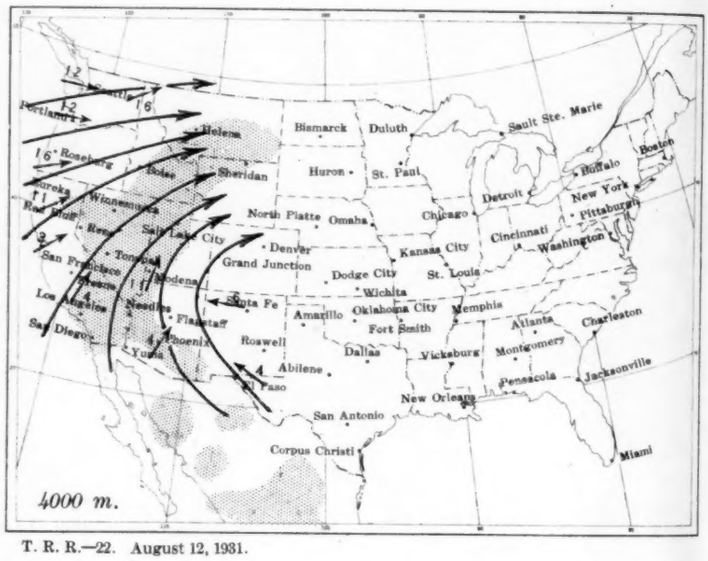
T. R. R.—19. August 9, 1931.



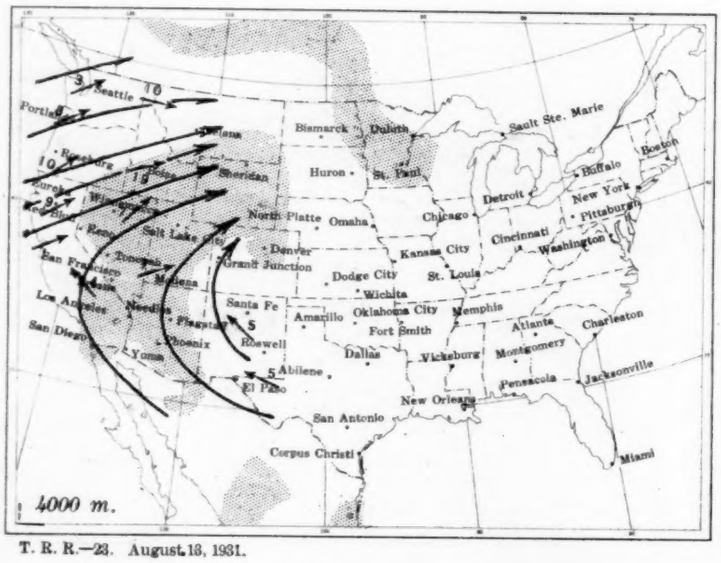
T. R. R.—20. August 10, 1931.



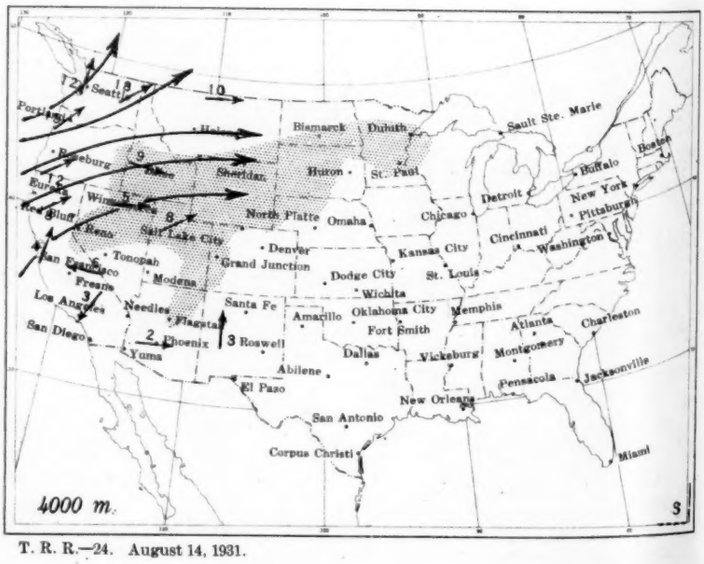
T. R. R.—21. August 11, 1931.



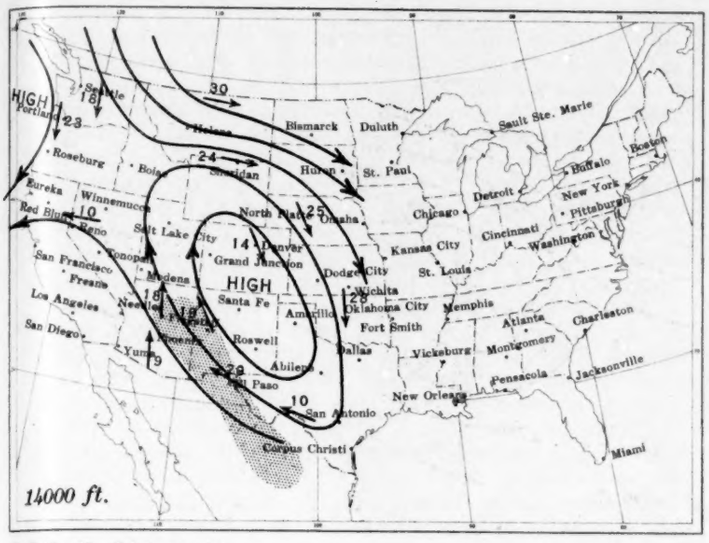
T. R. R.—22. August 12, 1931.



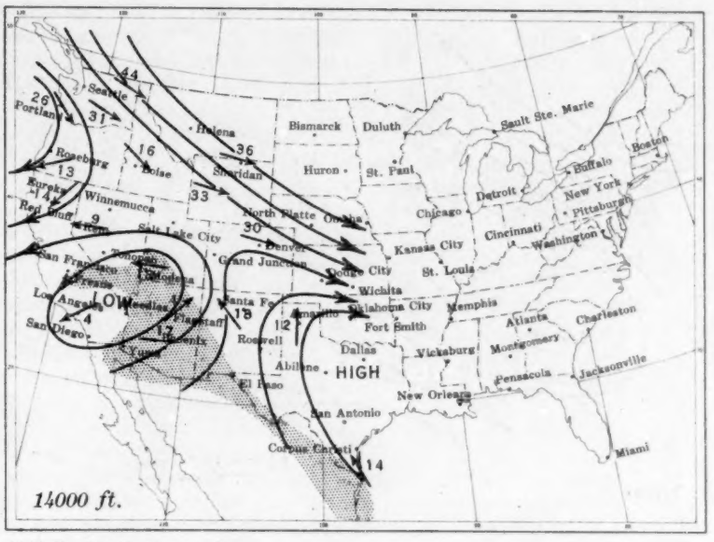
T. R. R.—23. August 13, 1931.



T. R. R.—24. August 14, 1931.



T. R. R.—25. October 9, 1933.



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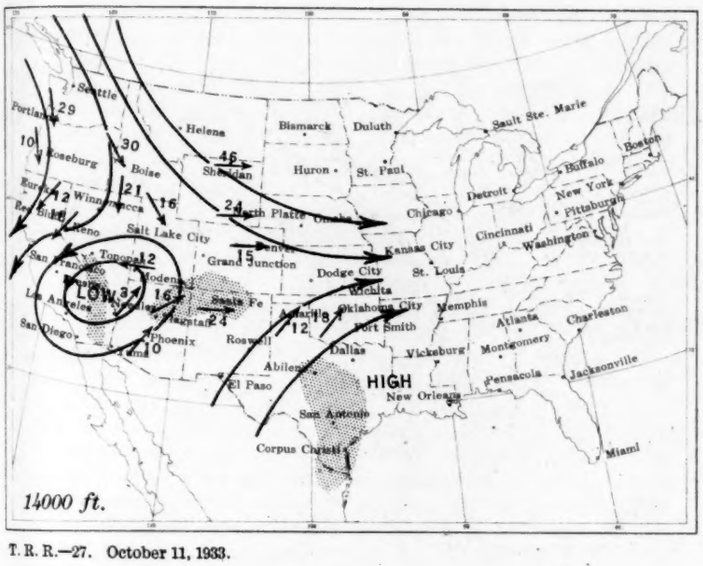
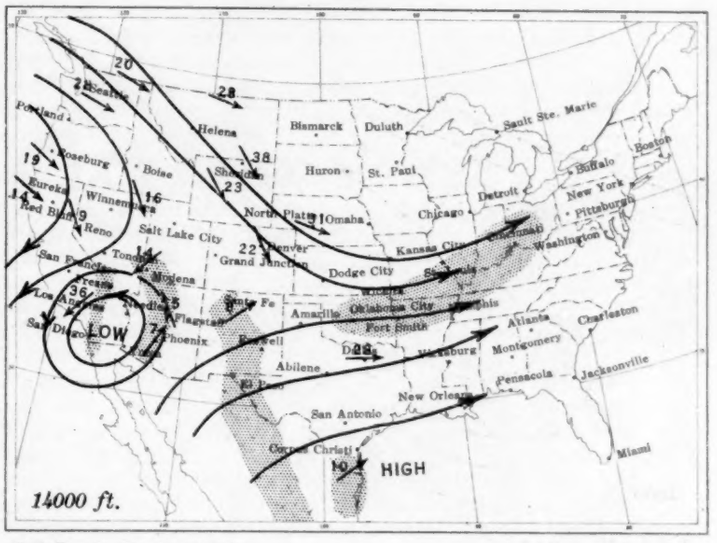
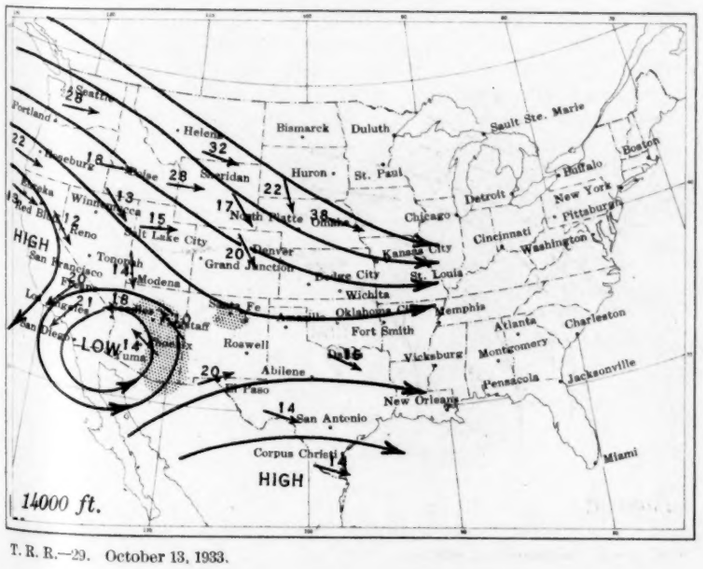


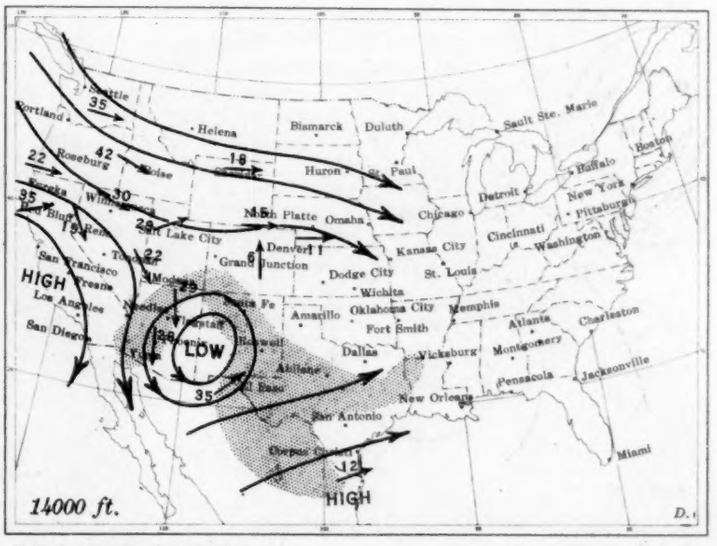
T. R. R.—27. October 11, 1933.



T. R. R.—28. October 12, 1933.

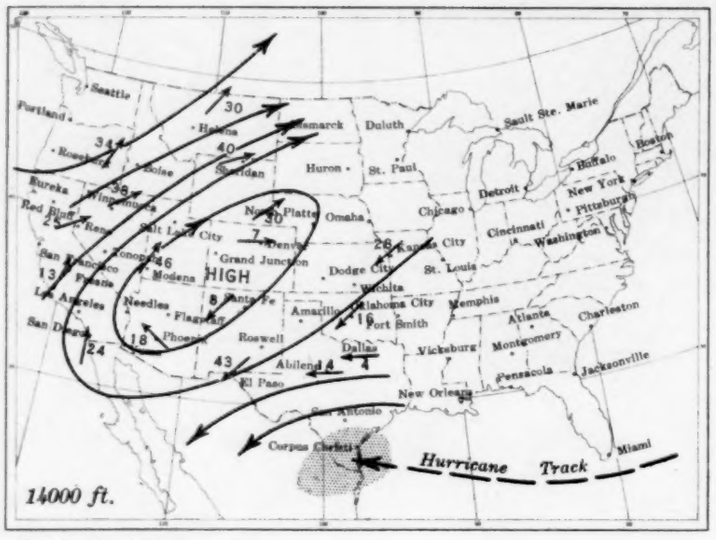


T. R. R.—29. October 13, 1933.

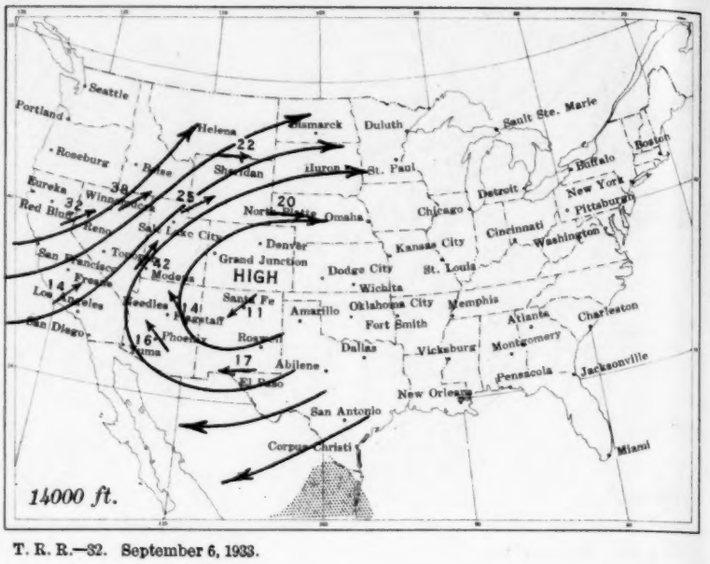


T. R. R.—30. October 14, 1933.

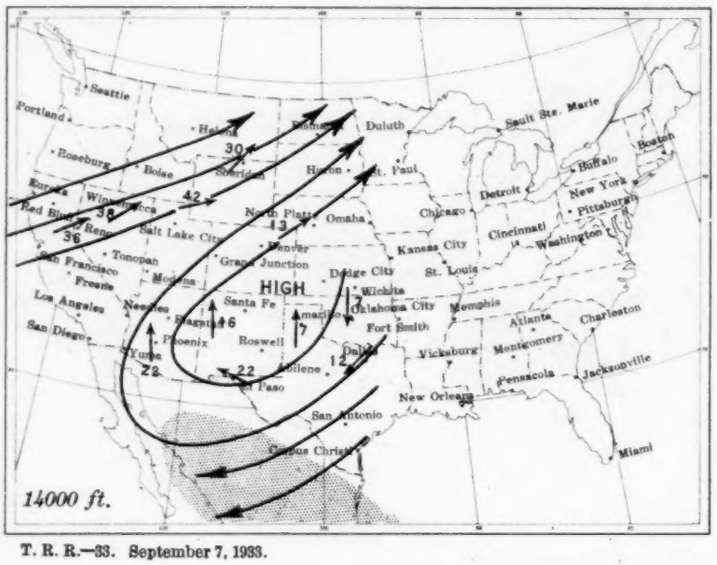
UNIV. OF MICH.



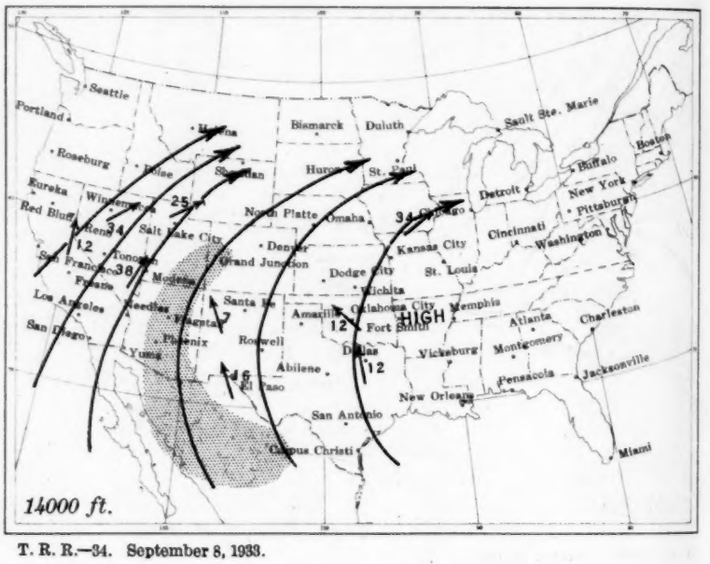
T. R. R.—31. September 5, 1933.



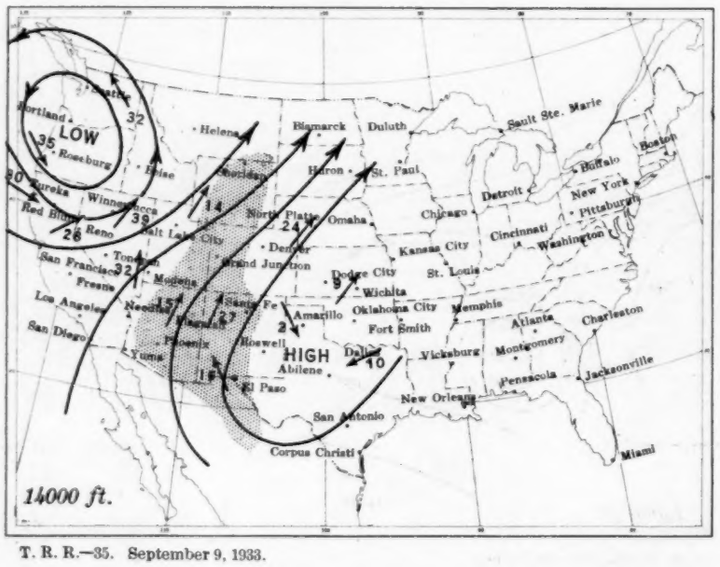
T. R. R.—32. September 6, 1933.



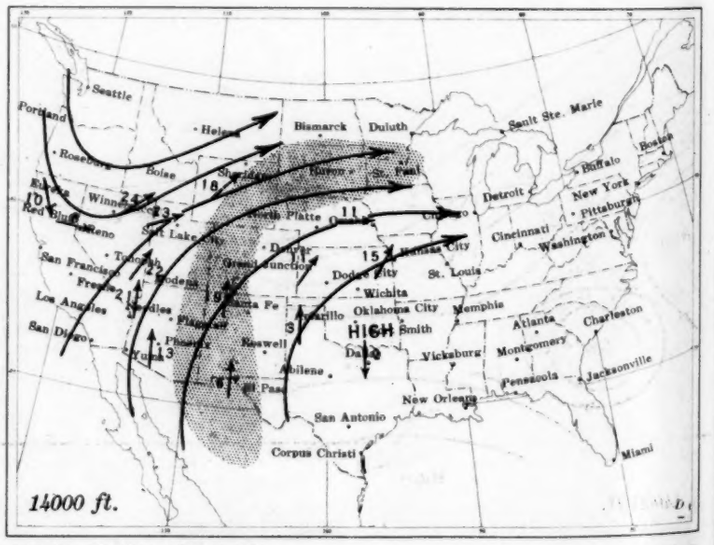
T. R. R.—33. September 7, 1933.



T. R. R.—34. September 8, 1933.



T. R. R.—35. September 9, 1933.



T. R. R.—36. September 10, 1933

labor the point of the relative instability of the atmospheric structure in those sectors. It is also plain that the upper portions of this mass are drifting around the anticyclone in a clockwise direction. Much of their moisture may be extracted before they reach the northern Mexican Plateau, and yet their state of conditional instability not materially altered by the journey, and hence, although the surface supplies of moisture may be scanty, surface heating is adequate to produce penetrative convection and occasional convectional rains. It is here that their clockwise turning often brings the upper winds northward over the southern Rockies, and it is then that what in Mexican terminology might be termed "chihuahua" or "Durango" rains, become in American parlance, "Arizona" rains. Moisture may or may not have been transported by them, but the essential requirement of conditional instability has been supplied by them, and so the vigorous convection initiated by the summer sun and aided by mountain slopes and ridges takes care of the rest. It is important in this connection that the student observe the sequence of rains. When rains are abundant over the Mexican plateau with the upper winds running toward the north, rains will likewise be abundant over the southern Rockies; when they cease over the Mexican plateau, they are also likely to become quite local or stop altogether over the west slope of the Rockies. Also, and of even greater import, when the anticyclone is centered west of the continental divide and there is consequently no importation of conditionally unstable air aloft, rains are practically certain to cease west of the Rockies; it is a "dry" type for the entire Southwest.

Now to return to the original question, Why is conditionally unstable air found so frequently over the Mexican plateau, and so seldom to the west of it? Why the sharp line of demarcation? One cause has been suggested, namely, the mountains fringing the western border of the Mexican plateau, down which the air crossing them in its circuit of the anticyclone must descend. Evidently this air loses nearly all its moisture in crossing this final barrier, and it also (which is more important) is warmed by descent. Being dry it retains its warmth, losing little heat by radiation thereafter, and moves northward over western Sonora and California, as an air mass of such stability that although supplies of surface moisture are abundant and surface heating the greatest in the United States, penetrative convection is prohibited and a rainless regime is assured.

Another item that may contribute to this effect is the greater steepness of the barometric slope aloft near the Pacific Ocean. In this region the contrast between oceanic chill and continental warmth is most extreme, and hence the pressure gradients in this sector of the anticyclone are quite pronounced. Conceivably there is a "sliding" of the air across the isobars in this sector which brings it to ever lower levels and consequently higher temperature in its northward journey.

This may be a fact of more importance than at first appears, as offering a clue to the occasional westward movement of the Arizona rain belt. When this event happens we see the Arizona rains transplanted to southeastern California, and the so-called "Sonora" storms in progress there. This situation is usually anticipated by east winds aloft over southern California[4] indicating clearly that conditionally unstable air from the Mexican plateau is drifting westward and introducing over the deserts and mountains of southern California the atmospheric structure which normally exists over the southern Rockies. The sources of this air and its movements can be traced by reference to upper wind reports and the progress of the rain area on the ground. The remarkable feature of this event is the fact that the air in such cases succeeds in making its transit from the Mexican plateau without being warmed by descent en route. Two circumstances may be mentioned as permissive of this possibility. One is that the east winds aloft which often precede this situation, imply a marked change in the direction of the isobars aloft. Instead of paralleling the coast they must be at some more or less acute angle to it. When parallel to it they are, as has been explained, crowded, with a consequent sliding off of the air, its descent and warming. When, on the other hand, the isobars aloft cross the coast line, as implied by easterly winds in the free air, they are not necessarily crowded, and the warming descent across the isobars is mitigated. The other contributing circumstance may be the vapor content of the air which crosses over. If its vapor content were relatively high, loss of heat by radiation might conceivably offset the effect of adiabatic warming, with the result that it would retain its conditionally unstable state after leaving the Mexican plateau and arriving over southern California. Observations supporting this view, obtained by airplane flights over San Diego, will be cited further on.

E. A. Beals in his paper on "The Semipermanent Arizona Low"[5] published before the advent of free air observations throughout the Far West, proposed the view that the barometric trough over the Far Southwest in summer ultimates occasionally in rain producing depressions which "bud off" from it and travel eastward. Their formation, however, was admittedly fortuitous, and no explanation could be offered for the development of convectional rains in the so-called trough at one time and not at another. We understand now that the depressions that seem to "bud off" from the trough are not contingent on a pressure situation implied by isobars drawn through Sir Napier Shaw's "ten thousand feet of rock", but on the temperature of the air imported aloft by the high-level anticyclone. When its temperature is low (relatively) or when the air mass is moist enough to cool by radiation as it travels, then we may expect to see rains associated with it, which travel forward with the unstable mass. The factor which determines their formation and travel, however, is not the apparent trough, but the air currents circulating aloft, which foster stable or unstable conditions according as their temperature is high or low. The phenomenon presents a vivid illustration of the second of Humphreys' three conditions by which a vertical temperature gradient necessary to convection can be

[4] Blake in his article on "Sonora Storms" (MONTHLY WEATHER REVIEW, November 1923) says: "After careful observation the writer has yet to observe a single instance of severe 'Sonora' conditions when the upper-cloud movement was other than from an easterly direction." It will be of profit to the reader to review this whole article as it describes in pleasing detail a far western weather type which baffled investigation prior to the advent of regular upper-air soundings in and around the region concerned. He will see that the term "Sonora" no more describes the origin of the summer rains and thunderstorms of southern California, than the term "Arizona rains" describes the source of like phenomena in the southern Rockies. Both are contingent on the establishment of a favorable lapse rate for penetrative convection, and this is provided not by a change in conditions below but by the introduction of suitable air aloft.

[5] MONTHLY WEATHER REVIEW, July 1922.

established, viz, "the overrunning of one layer of air by another at a temperature sufficiently lower to induce convection."[6] The quotations would be still more apposite if we substitute the word "sustain" for "induce", as convection in the cases we are considering is usually *induced* by surface heating but *sustained* to the point of condensation by the lapse rate provided by the overrunning air.

I have said that the prime necessity is either "cold" air aloft, or air that is moist enough to cool by radiation in its travel. In either event we secure the desideratum for the formation of cloud and rain, viz, instability. And I have cited Beals as pointing out that when this condition (which he associated with the summer trough) exists, active depressions sometimes ensue. That cyclonic circulation sometimes does develop is shown by data plotted on the free-air wind charts. Such circulation is never confirmed by surface observations as the rugged west-continental relief prohibits even approximate conformity to gradient wind requirements near the ground. But at levels above the disturbing element of mountain peaks and ridges the air is occasionally found to be circulating in a counterclockwise direction on the periphery of the high-level anticyclone. The fact that this phenomenon is more likely to appear in the fall than in midsummer implies that the lengthening nights of autumn may be a contributing factor. This has led E. H. Bowie, to suggest that cooling of moist air aloft by radiation from its vapor laden strata is responsible. Such cooling over a wide area would result in a subsidence or "shrinking" of the strata. To be sure this would in turn produce dynamic warming, but if radiative conditions were suitable they might offset it. The resulting local concavity in the isobarometric surfaces, Bowie further points out, might result in inflowing, counterclockwise winds aloft and the development of a cyclonic circulation at high levels. The idea is certainly ingenious, and deserves being followed up with a searching quantitative analysis.

But whatever the cause, the phenomena are undeniable. And so we see rains on the periphery of the high-level anticyclone associated at one time with a local counterclockwise system of winds and at another time with an undisturbed current turning slowly around the anticyclone in a clockwise sense. But the essential requirement in either case seems to be the importation or manufacture of conditionally unstable air aloft, after which convection initiated by surface heating and aided by mountain slopes has a free hand.

The air mass, associated with a hurricane is obviously unstable; hence it is easy to identify it by the progress of the ensuing rain over the land after the storm has broken up on the coast and all trace of a vortex has disappeared from the weather charts. Many of the rains over the Far Southwest can be directly traced to the passage of "hurricane air" around the high-level anticyclone, sometimes coming from the east Mexican coast and sometimes from the West. The Mexican broadcast of weather observations is a vital necessity in this research, and if it included upper air reports as well as surface data the assitance would be inestimably greater. A regular practice in the San Francisco office of the Weather Bureau, after the receipt of this broadcast, is to plot the Mexican rain area on the aerological chart showing upper winds at the 14,000-foot altitude, and to note the consistency of its travel with the implied general circulation of air at that level.

[6] Physics of the Air, p. 309 (2d edition).

Precepts and examples.—It may be rash to attempt the formulation of rules with so little observational experience to draw upon, and the inclusion of the term "precepts" in the topical heading may seem, to say the least, premature. Certainly, however, no objection can be raised to citing examples designed to illustrate and support assertions made in the preceding text, and it is believed that their contemplation will bring conviction where pages of argument might not suffice.

To begin with, let us take the simplest and most fundamental proposition, namely, that when the anticyclone is centered east of the Rockies conditions are favorable for the usual instability rains of the "Arizona" type, and unfavorable when it is centered west of the Rockies. In support of this it would be easy to find a great number of examples, but one that illustrates it with perfection will be found in the free air situation prevailing in September 1932. During the first 3 weeks of that month the anticyclone was centered almost continuously west of the Continental Divide, most of the time over Nevada, southern California or western Arizona. During this entire period an almost rainless régime prevailed over and west of the southern Rockies. It was a subject of remark by section directors in their weekly weather and crop reports: All Rocky Mountain stations reported a deficit of rainfall. On the 20th of this month the center of the anticyclone shifted east of the Rockies and almost simultaneously rains were reported at Tucson and El Paso, reaching Flagstaff and Santa Fe on the 21st, and running north into Utah, Colorado, and Wyoming by the 23d. The anticyclone remained east of the Rockies for the reminder of the month. The "Weather and Crop Bulletin" of September 27 showed an excess of rainfall at Amarillo, El Paso, Roswell, Santa Fe, and Flagstaff, a condition repeated the following week (except for a slight deficit at Santa Fe) and made the subject of remark by section directors, the New Mexico official reporting the week as "cloudy, cool, and rainy", and the Arizona official as characterized by "much cooler weather, with mostly light to moderate beneficial rains."

Another precept of importance is that an existing rain "area" shows a marked tendency to progress in the direction of the upper winds. Take for example the situation in August 1931. (Charts 13 to 18.) On the 1st showers and thunderstorms were general east of the Continental Divide, but the weather was rainless to the west of it. East winds were running aloft over southern Arizona and within 36 hours the Texas rain area had pushed westward over the border States as far as Yuma. On the 4th the center of the high-level anticyclone shifted to the eastward; winds over Arizona were consequently running from the south instead of from the east, and by the morning of the 5th the rain had turned northward, too, and covered all the lower Colorado Valley, eastern Nevada and western Utah, extending into the northern Rockies and the Dakotas by the 8th. During this period rains had been general over the Mexican Plateau, but on the 6th they began to cease. Within 2 days they also ceased nearly everywhere in our States west of the Continental Divide. A régime very like the one just described began again on the 9th (charts 19 to 24) with winds aloft setting in from the east over the southern border and later veering to south and southwest as the center of the anticyclone moved eastward. Rains, as before, spread westward from New Mexico, this time reaching the southern California coast, whence they ran northward with the veering wind stream aloft, covering eastern

California and Nevada by the 12th and reaching Wyoming by the 14th. On the 13th they had begun to cease in nothern Mexico, and within 3 days had practically ceased in the plateau region, California, and western Arizona.

In considering these and other examples of a progressive rain, the reader is asked to keep in view the fact that the moisture deposited as rain is not necessarily imported from sources suggested by the rain area. No such claim is made. All that is required to be imported is air of suitable temperature aloft to permit penetrative convection. With this atmospheric structure established existing supplies of surface moisture are ample to account for the attendant phenomenon of precipitation. That is why the summer rains of the desert region of southern California, on the rare occasions when they do occur, are likely to be more abundant than elsewhere, sometimes reaching cloudburst proportions. The moisture to produce them is already there in more abundance than in adjacent regions to the eastward: all that is ordinarily lacking to produce convective rains is a lapse rate permissive of ascending air.

It will be remarked that the foregoing examples also serve to confirm Blake's observation that "Sonora" rains are preceded by easterly winds at high levels. This was again confirmed during the month in review (August 1931). Winds aloft over southern California were from the east on the 25th. Then the center of the high-level anticyclone shifted east of the Rockies and on the 27th rains fell over southern California and southern Arizona, running northward into the southern plateau region by the 29th. By that date a high-level cyclone was in evidence, apparently centered near and west of the southern California coast.

By a "high-level cyclone" is meant a system of counterclockwise winds aloft, a phenomenon, as has already been said, which is not uncommon over the far western United States, and which sometimes seems to originate in upper air which has been transported into those regions by the agency of the high-level anticyclone. Such developments are not necessarily indigenous to that air, but in the warm season it is their likeliest source. The search for "fronts" in this situation is futile, and the phenomenon seems best explained by Bowie's hypothesis (already referred to), namely, a local sinking or contraction of the upper strata caused by free air cooling. The essential requirement for such cooling is, of course, a vapor mass aloft to serve in a radiative capacity, and that this may be occasionally supplied there is specific evidence. This evidence has been found in recent aerological flights made by airplane over San Diego, Calif. To cite a particular case, the period September 27 to October 15, 1933, has been selected. (Charts 25 to 30.) Prior to September 27, winds aloft over southern California had been from the west and the weather over the far southwest rainless. On the 27th winds aloft over San Diego became easterly, indicating a movement of upper air from the Mexican Plateau where rains had been in progress. Within 24 hours the dew point at 4,000 m over San Diego had risen 35° (from −1° F. to 34° F.) while the temperature had fallen 6° F. This condition of relatively high dew point continued until October 12, during which time there was an irregular decline in temperature at the same level reaching a minimum on that date of 22° F., after which the dew point fell abruptly and the temperature rose. Prior to September 28, as has been said, the weather had been rainless, but on the 28th (the day after the wind aloft had reversed direction and set in from the east) thunderstorms occurred in the mountains of southern California, continuing at intervals until October 12. On October 10, when the cooling aloft had nearly reached its maximum, a cyclonic circulation was clearly in evidence at the 14,000 foot level with the vortex over the lower Colorado Valley. This circulation persisted over that region for 4 days and then drifted eastward to the southern Rockies.

In conclusion, it is desired to cite two examples of the transportation by the high-level anticylcone of air masses associated with the development of hurricanes. In one case the hurricane was an east coast phenomenon, and in the other it formed and disappeared in the west, but in each case the air mass in which the hurricane had flourished moved in channels evidently determined by the anticyclone.

The first of these (charts 31 to 36) dissipated near Brownsville, Tex., on September 4, 1933, after having crossed the Gulf of Mexico. At this time the anticyclone was centered over the southern Rockies, and winds aloft over Texas were from the east-northeast. Presumably over northern Mexico they were substantially the same. On the 5th the rain was evident only over the region where the hurricane had disappeared, but by the 6th it had crossed Mexico toward the southwest, and torrential rain had fallen at Monterey. On the 7th it had expanded and spread northward on the west coast as far as Culiacan, with very heavy rain recorded at Mazatlan. On the 8th with the anticyclone transferred to the Gulf States and winds aloft running toward the north everywhere west of the continental divide, the rain began to spread northward, covering eastern Arizona and reaching Grand Junction, Colo. On the 9th with south winds still running aloft, the rain continued northward into Wyoming, with general rains prevailing along the west slopes of the Rockies, which were extended by veering winds aloft into the Plains States the day after.

The west coast example (charts omitted) is the hurricane of September 1932 which appeared off Manzanillo on the 27th, was charted at sea on two succeeding dates as it moved northward, and finally disappeared in the lower Gulf of California on the 29th. The air in which this disturbance originated has been associated by competent meteorologists with the torrential rains which occurred simultaneously in the Tehachapi Mountains of southern California, washing out railroads and highways, and involving property damage estimated at over a million dollars.[7] The high-level anticyclone appeared to be somewhere over the Gulf States, as winds at high levels were running from the south over the Mexican border States. On September 29, the last day on which the hurricane appeared in the form of a surface vortex on the weather chart, rains and thunderstorms were reported over nearly all of Mexico except regions bordering on the Gulf of California (where only a few reporting stations are located) and also over nearly all of New Mexico, Arizona, and southern California. Obviously the hurricane was not responsible for all these events; but the atmospheric structure which fostered the formation of one also fostered the formation of the others, and the travel of this structure was necessarily from south to north in the path of the high-level winds. On the 30th there was evidence of a high-level cyclone over southern California, but winds aloft over Texas and New Mexico had veered toward the east. Hence while rains continued in southern California and Arizona, the Mexican rain area pushed northeastward across New Mexico into the Texas Panhandle and Oklahoma.

[7] Destructive Rains in the Tehachapi Mountains, Kern County, Calif. Malcolm Sprague. Climatological Data, California Section, October 1932.

TENNESSEE FIREBALL OF AUGUST 21, 1933

By STERLING BUNCH and CHARLES P. OLIVIER [1]

On August 21, 1933, at 7h39m39s p.m. (C.S.T.), a splendid fireball appeared over Tennessee, moving almost north to south and ending over a point just north of Knoxville. By good fortune S. Bunch, regional director for the American Meteor Society in Tennessee and Kentucky, saw it and secured full observations. Two other experienced A.M.S. members, L. J. Wilson and P. S. Watson, also observed it. Requests for observations were at once published by Bunch in local papers. These notices brought in reports from other observers. We give below a table showing the stations, the names of observers, the color of the fireball, and the estimated durations of the fireball and of the train.

TABLE 1

Station	Observer	Color of fireball	Duration of fireball	Duration of train
1. Knoxville, Tenn.	S. Bunch	B-W	0s.8	3m15s.
2. Franklin, Ky.	L. J. Wilson		"Slow"	3m.
3. Pulaski, Va.	P. S. Watson	R-B	6s	3m±.
4. Jefferson City, Tenn.	F. Weed, Jr.			30s.
5. Newport, Tenn.	C. E. Parrott	Blue		30s.
6. Clarksville, Ga.	C. H. Fonde			1m±.
7. Boyds Creek, Tenn.	T. W. Stansbury		2s	
8. Near Jefferson City, Tenn.	W. A. Burkhart			2-3m.
9. Johnson City, Tenn.	H. Leonard			2m±.
10. Washburn, Tenn.	L. M. Cleveland			"Long."
11. Bearden, Tenn.	Mrs. Chas. Seiber			2m±.
12. Chattanooga, Tenn.	W. H. Wilson			
13. Coal Creek, Tenn.	Mrs. Earl Martin			4-5m.
14. Cleveland, Tenn.	R. G. Parks			50-70s.
15. Rockwood, Tenn.	J. E. Johnson	B		1m+.

The data were handled as follows: Bunch made a preliminary solution with partial data; he then sent all reports to Olivier, who made a complete solution; the reports were finally returned to Bunch, who independently made a complete solution. It is considered that the publication of the principal results thus deduced is of interest, for each author used his personal judgment in measuring the plots and weighting the calculated quantities. The close agreement of the results gives us added confidence in them.

TABLE 2

	By S. Bunch	By C. P. Olivier	Adopted
Height, beginning	171.8 km	169.7 km	170.8 km.
Height, ending	45.5 km	44.7 km	45.6 km.
Length of path	143.4 km	144.5 km	144.0 km.
Projected length of path	69.9 km	72.3 km	71.1 km.
Slope=h of radiant (uncorrected)	60°.5	60°	60°.2.
Azimuth=a of radiant (uncorrected)	187°	187°	187°.
Began over	83°45′ +36°43′	83°44′ +36°43′	
Ended over	83°51′ +36°05′	83°51′ +36°04′	
Earth point=E_1		83°52′ +35°50′.4	
Height of mid-point of train	81.4 km	80.4 km	80.9 km.
Velocity of train drift (minimum)	129 km/hr.	127 km/hr.	128 km/hr.
Local siderial time at E_1			270°57′.8.
Zenith correction (parabolic velocity assumed).			−0°55′.
Radiant (corrected)			α=278°.8. δ=+64°.7.

Bunch estimated the brilliancy of the fireball as greater than that of the full moon, its angular diameter approximately as great as the moon's, and its duration as 0.8 of a second. The train lasted 205 seconds, and he plotted it five times during this interval. Its change from a definitely outlined, irregular, sinuous train to an ill-defined roundish mass of light occurred within 20 seconds, as he saw it (very greatly fore-shortened, however, as he was almost in the line of motion of the fireball). Wilson (station 2) gives: Diameter equal to two thirds that of the moon; visibility of train, longer than 2 minutes; four drawings of train made. He was in such a position that the train was drifting almost directly away from him. Watson (station 3) gives: Head nearly equal to full moon; color, red and blue; speed, fairly fast; duration, 6 seconds; train seen for 3 minutes, drifting eastward. He plotted on a chart the final position of the train. According to this observation, just before disappearance, its lower end had a height of 57 km, its upper end, 108 km. The drift was almost directly toward him, and hence appeared slightly upward. All of the other observers confirm these general statements, but lack of space prevents us from quoting their reports here.

The observations of 6 observers could be used in determining the beginning point and of 8 observers for the end point. The beginning point is fixed with fair accuracy for this type of work, and the end point with great accuracy. It is evident from the few and widely divergent estimates of duration of visibility of the fireball itself that no reliable relative velocity can be deduced. As usual, therefore, parabolic velocity has been assumed and the zenith correction calculated. The radiant point was then found. In the von Niessl-Hoffmeister Catalog, fireball no. 377, seen October 1, 1893, shows striking similarities in description and radiant, making allowance for the expected shift in the 8-day interval.

This fireball was obviously a very fine one, of a distinctly blue color, and the case was favorable for the study of train drift. Train drifts being of fundamental value for the investigation of currents in the upper atmosphere, in fact, our only means of determining such currents, no pains were spared to secure the best results. We conclude that the train drifted almost horizontally in an easterly direction, that is on a west wind, with a minimum velocity of 128 kilometers per hour. If there was any deviation, it was slightly to the south of east, but by assuming east we could scarcely be 15° in error. If we do assume that direction of motion the velocity will be about 2 percent greater than the minimum given above. The fireball itself came so low in the atmosphere before bursting that it is not improbable that meteorites fell from its debris. The observations from station 1, since they were practically at right angles to the direction of drift, are the ones mainly used to derive the velocity.

TABLE 3.—*Wind velocities and directions from surface to 7.8 km as determined from pilot-balloon observation begun at 4:30 p.m. (C.S.T.)*

Altitude (km)	Direction	Velocity (km/hour)
Surface	Northeast	13.0
0.5	do	19.4
1.0	do	16.6
1.5	do	18.4
2.0	East	19.1
3.0	Northeast	15.8
4.0	do	17.3
5.0	North	19.4
6.0	Northeast	8.3
7.0	North	14.4
7.8	Northwest	9.4
Cirrus clouds	West	

6:45 p.m., C.S.T., barometer, 29.96 inches; temperature, 82°; weather, clear.

[1] I beg to call to the attention of all Weather Bureau observers their unexcelled opportunities for the collection of data on fireballs. If, when one is reported, they would put notices in local papers stating what data are needed, in most cases they would meet hearty response. The American Meteor Society will willingly undertake the reduction of all reports sent to headquarters, giving full credit to the observers.—C.P.O.

The wind velocities derived from this and other train drift studies are not incomparable in magnitude with velocities encountered nearer the surface. The conditions in the lower atmosphere near the time of the fireball is, therefore, of some interest. Table 3 is made up from data taken from the records of the Knoxville Weather Bureau office for that date.

This is the third velocity of the drift of a meteor train secured by the American Meteor Society within a year. It further illustrates most excellently what can be accomplished by cooperative effort.

For this paper, the initiative in observing and in securing the reports of others is due to S. Bunch; also an independent solution was made by him. C. P. Olivier has made a critical study of the data, computed the quantities given under his name, and exercised a general supervision, as is usual in the American Meteor Society work.

The highest wind velocity observed at Knoxville by the pilot-balloon method was at 1.5 km above surface, 201.6 km per hour, but this was in November. Summer velocities of near 100 km per hour have been observed.

AN 18-DEGREE HALO

By E. MONROE HARWOOD

[Blue Hill Meteorological Observatory, Milton, Mass., December 1933]

A lunar halo at Blue Hill Observatory, Milton, Mass. which began at 7:10 p.m. (E.S.T.) October 4, 1933, and continued until after 12:40 a.m., October 5, at first was mistaken for the common one of 22° radius but later seemed noticeably smaller; so measurements were made on it with an astronomical stick graduated in degrees and tenths. At 12:40 a.m., October 5, two such measurements both showed 18°12′ as the angle from the near edge of the practically full moon to the inner edge of the halo, horizontally, on the right-hand side of the moon. The halo was of marked brightness. No other halo was observed at the time, but there was a bright corona, of approximately 3° radius. The sky was completely covered with cirrostratus in a uniform sheet.

NOTE.—This halo is the 18°58′ halo (yellow light) listed in "Physics of the Air", 2d edition, page 517, produced by pyramidal faces inclined to each other 53°58′. Clearly, because red light, corresponding to the inner edge of the halo, gives a radius of 18°20′ which, when diminished by the radius of the moon, 15′, to correspond with the angular distance measured by Mr. Harwood, reduces to 18°5′, a value identical, to well within the observational errors, with that which he found, namely, 18°12′.—Editor.

A HALO OF UNUSUAL RADIUS

By ROBERT G. STONE and SALVATORE PAGLIUCA

[Mount Washington Observatory, Gorham, N. H., Oct. 7, 1933]

From 7:30 p.m. until sometime after 10 p.m., October 4, 1933 (75th meridian time) we saw from the Mount Washington Observatory, New Hampshire, 1,911 meters above mean sea level, a bright, complete, circular halo that, with a theodolite, repeatedly and consistently measured 23.5° from its inner edge to the proximal limb of the nearly full moon. The elevation of the moon above the horizon at 9 p.m. was about 37°.

The ring was of approximately equal brightness and width all around. No trace of the 22°-halo, or any other halo than the one measured, was seen. The sky was completely covered with a thick uniform veil of cirrostratus (species, *nebulosus*, in the 1932 International Atlas of Clouds) that appeared to be unusually low (the appearance of the sky is almost exactly reproduced on plate 43 of 1932 International Atlas of Clouds). The pressure had been falling slowly since morning after 2 days of high barometer and fair weather. Delicate cirrus prevailed during the day, giving way to cirrostratus about 6 p.m. The temperature at 8 p.m. was 30.6° F.; relative humidity, 71 percent; wind, ESE (all day) at 17 meters per second.

The halo was first measured several times with an astronomical stick which though giving only rough readings, indicated radii considerably greater than 22°. Suspicion and curiosity were thus aroused and readings then made with a Keuffel and Esser theodolite of modern design adapted to pilot balloon observations. These measurements were made in three ways, viz: (1) from the outer proximal limb of the moon *right* to the inner edge of the halo, (2) from the outer proximal limb of the moon *up* to the inner edge of the halo, and (3) from the inner edge of the left limb of the halo horizontally through the center of the moon to the inner edge of the right limb of the ring, and, as stated, repeated several times with always the same result.

At 8 p.m., the same evening, L. A. Wells at the Blue Hill Observatory, Milton, Mass., noted 0.8 Cirrus and Cirrostratus filosus, at an estimated altitude of 8 km., moving from SW. at a speed which earlier observations indicated to be approximately 25 meters per second. A solar halo, beginning at 8:04 a.m., exhibited right and left parhelia from 4:05 p.m. until after 4:10 p.m. A lunar halo began at 7:10 p.m. and continued until after 12:40 a.m., October 5, with an equally bright corona of approximately 3° radius also persistent. Finger measurements of the solar halo by E. M. Harwood indicated 22° approximately. Astronomical stick measurements of the lunar halo at 12:40 a.m. the 5th gave 18.2° as the radius in two readings taken from the apparent edge of the moon to the inner edge of the halo, horizontally, on the right-hand side of the moon. Observer Harwood noted even before making the measurements the small size of that halo and its marked brightness. No other halo was observed at the time; the sky was completely covered with Cirrostratus in a uniform sheet.

(All times given above are 75th meridian time (E.S.T.).)

THE MOUNT WASHINGTON (NEW HAMPSHIRE) HALO OF OCTOBER 4, 1933

By W. J. HUMPHREYS

The article in this number of the MONTHLY WEATHER REVIEW by Messrs. Robert G. Stone and Salvatore Pagliuca on the Mount Washington (N.H.) halo of October 4, 1933, deserves especial attention, since it gives an account of repeated measurements, by means of a theodolite, of a rare halo, one which, so far as I know, never was so carefully measured before, if indeed ever before measured at all.

The value obtained, 23°30′ was, as stated by the observers, the angular distance from the inner edge of the halo to the nearest limb of the moon, whereas halos commonly are measured from the center of the moon, or sun, to about the middle of the yellow band (in the case of colored, or refraction, halos such as this one was) which itself is roughly half-way between the inner and outer edges of the halo.

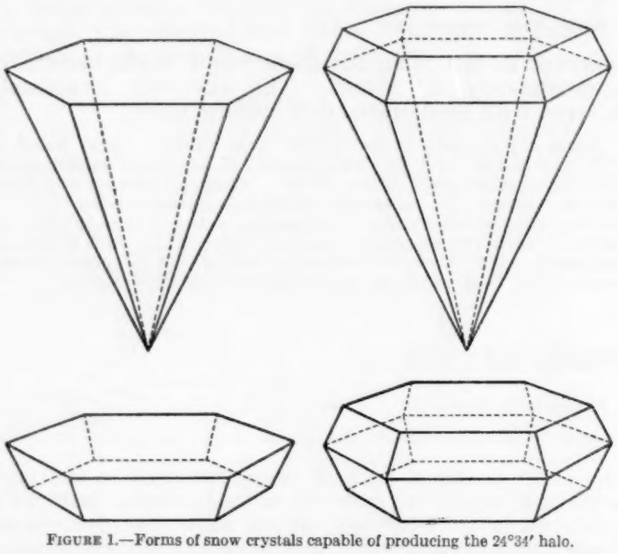


FIGURE 1.—Forms of snow crystals capable of producing the 24°34′ halo.

If, therefore, the measurements of this halo had been from the center of the moon to about the middle of the yellow band the value found would have been appreciably greater than that gotten by the method followed, namely, 23°30′. This seems to exclude, as a possibility, the 23°24′ halo, listed on page 517 of Humphreys' Physics of the Air, 2nd Edition, and computed for sodium yellow light, refractive index 1.31, and measured from the center of the luminary, sun or moon. That is, this halo is ruled out if the slope of the pyramidal face of the crystal to the longitudinal axis is 24°51′ (adopted, after computation, in Physics of the Air), or thereabouts. It is further excluded by the fact that the occurrence of this 23°24′ halo requires the presence of columnar crystals pyramidal at one end, or both, that would produce, by the columnar portion, the 22° halo also, which was not observed.

Suppose, therefore, that in the main the crystals had no columnar segments but were chiefly one or more of the unusual but well-known pyramidal types shown in figure 1; that is, a single right pyramid, truncated or not, or a double right pyramid, base to base, having one end, or both, truncated.[1] Suppose, further, that the slope of each pyramid face to the longitudinal axis was 24°51′, as adopted in Physics of the Air, for the reasons explained there. Then compute the angular radius of the halo produced by lithium-red light (substantially the kind at the inner edge of the halo to which the measurements in this case were made), refractive index 1.30, through the angle 65°9′, between the base of a pyramidal crystal and its side face, figure 2, in which figure a base diagonal is perpendicular to the plane of the paper. The result is 23°42′. From this value, in turn, subtract 15′, the radius of the moon, then nearly full and around 35° above the horizon, to get the angular distance from the inner (red) edge of the halo to the nearest limb of the moon, the measurement made by Messrs. Stone and Pagliuca. The value thus computed is 23°27′, while their measured value was 23°30′, a decidedly closer agreement than one reasonably could expect.

If these pyramid crystals had been substantially free from internal flaws and cavities two or three other well-known but unusual halos would have been formed, namely, the 17°6′ halo (yellow light) and 31°49′ halo, known, respectively, as the 17° halo and the 32° halo, if the pyramids had been single, and in addition the 19° halo if they had been double. As these halos were not seen [2] the presumption is that at least most of the crystals were large enough to be so filled with cavities (the larger the crystal the greater, in general, its defects, especially in the diagonal planes symmetrical about the longitudinal axis) that light could not pass through their centers in the regular manner it would have passed if they had been solid throughout and flawless. Furthermore, since the halo was equally bright throughout its circumference, the crystals that produced it evidently fell in random attitudes, and therefore presumably were truncated, double right pyramids, as indicated in figure 2, with lengths between truncate faces considerable fractions of the respective widths—such fractions as would secure irregular attitudes in falling and at the same time, since the halo was quite bright, provide the maximum, or near maximum, amount of properly refracted light.

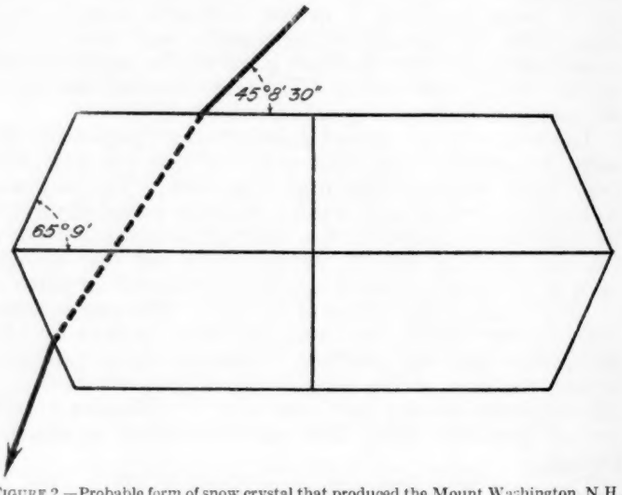


FIGURE 2.—Probable form of snow crystal that produced the Mount Washington, N.H., halo of October 4, 1933.

[1] Scoresby says, on p. 430, vol. 1, of An Account of the Arctic Regions, that he saw pyramidal snow crystals only once, but then in large quantity. Dobrowolski reports, in Results of the Voyage of the Belgica, having seen frost crystals of these shapes in the Antarctic.

[2] None of them was seen at Mount Washington, though at the same time the 19° halo alone was seen at the Blue Hill Observatory in Massachusetts, as reported by Mr. E. M. Harwood in the November 1933 issue of the MONTHLY WEATHER REVIEW—this issue.

We conclude therefore:

1. That the halo in question was the rare 24°34′ halo listed in Physics of the Air, second edition, page 517.

2. That the cirrostratus cloud that produced it consisted largely of pyramidal crystals—probably stubby, truncated double right pyramids.

3. That the slope of the pyramid face to the longitudinal axis is very close to 24°51′, as computed in Physics of the Air.

Naturally one asks why the snow crystals in such large quantity had this unusual form. Possibly owing to the presence of minute quantities of some impurity, if one might so infer from the sensitivity, in many cases, of crystal form to foreign substances. But that is just a rational surmise. The problem is distinctly one for an interesting investigation.

THE WINTER OF 1932–33 AT FAIRBANKS, ALASKA

By R. L. FROST

[Weather Bureau Office, Fairbanks, Alaska, Nov. 16, 1933]

[Temperatures in degrees Fahrenheit]

At Fairbanks, Alaska, the first killing frost of the fall of 1932 occurred on September 1 and 3 weeks later the first snow fell. Ice began running in the Chena River on October 14 and the river froze over on the 31st. The first zero or subzero temperature also occurred on the 31st. From the 23d of October to the 14th of March the temperature remained below 32°, making 4 months and 3 weeks of continuous freezing weather. There were many days in September and October with freezing temperatures and snowfall, but in the interior of Alaska not that but the freezing over of the rivers is usually considered to mark the beginning of winter. In 1932 the Chena River at Fairbanks froze over on October 31 and the 5 following months are of considerable interest due to the extremely low temperatures recorded. The mean daily temperature during these 5 months was −8.7°. The first dogsled was seen on the streets October 27. It was about this time that airplanes operating over the airways of interior Alaska began using skii landing gear.

November began with a minimum temperature of 10° below zero and a maximum for the day of 5° above. The highest temperature for the month was 19° and the mean of 8.2° was 11.3° below normal. The highest barometric pressure, 30.55 inches, occurred on the 9th, and the lowest, 28.97 inches, on the 25th, the date also of the maximum temperature. November was the only month during the winter with a temperature of zero or below recorded every day. There were 13 days with maximum temperature below zero. Ice in the river averaged 25 inches in thickness at the end of the month, and just to show what late fall weather is like in the Alaskan interior, Dame Nature ushered it out with a minimum temperature of −30°. The maximum of the last day was 20° below zero.

December began with comparatively mild weather. A storm center moved in and the lowest barometric pressure, 29.11 inches, occurred on the 2d. The minimum temperature for the day was −12°. The low-pressure area moved out rapidly and on the 5th the barometer registered 30.94 inches—the highest for the month. On that day the temperature dropped to 39° below zero. However, it was not until the 23d that unusually cold weather prevailed. From that date to the end of the month the mean temperature was −33.8°. The maximum temperature for the month was 27° on the 9th. There were 30 days with minima zero or lower, and on 14 days the maxima were below zero. The mean temperature for the month was −13.1° which is 6.9° below normal. During the last 6 days the total wind movement was but 15 miles, and on the 28th every hour of the day was calm. Ice in the river averaged 37 inches thick at the end of the month.

On December 21 the time of sunrise was 9:58 a.m. and sunset, 1:38 p.m., giving 3.7 hours of possible sunshine. The altitude of the sun at noon was 1°42′. At 10 a.m. the brightest stars were visible in the western sky. On June 21 sunrise was at 12:56 a.m. and sunset at 10:50 p.m., giving 21.9 hours of possible sunshine and 24 hours of daylight. The old year was ushered out with a temperature of 47° below zero and a maximum for the day of 41° below.

December had been a very cold month but it proved to be a mere sample of what was to come in January. Those who attended the New Year's dance did not loiter long on the streets as the minimum temperature on the 1st was −42° and the highest during the day −38°. The cold spell which began on December 23 continued until January 9, a total of 18 days, during which time the temperature was never above zero. The mean temperature for this period was −35.2. When the cold spell broke the temperature rose from −41 on the 9th to 12° on the 10th. Mild weather prevailed from the 9th to the 23d and during this period 17.8 inches of dry, powdery snow fell. On the 23d day a severe cold wave began and continued to the end of the month. For this period (24th to 30th) the temperature averaged −41.1. The 27th was a very cold day with a maximum of −44° and a minimum of −57°, but on the following day the thermometer reached 60° below zero, a point which was equaled in 1916 but has not been exceeded for 22 years. At 2 p.m. the temperature rose to −47° which was the maximum for the day. For two periods of 14 hours each the temperature ranged between 55° and 60° below zero. It was then that many people who ventured outdoors had the unique and eerie sensation that occurs when one can hear his breath freeze. As usual on very cold days a dense ground fog prevailed over the city. On this occasion the dense fog persisted for 53 hours. The mean temprature for the month was −23.5° which is 13.2° below normal. There were 21 days with maximum and 28 days with minimum temperatures zero or lower. Starting on the 27th and ending on the 29th there was a period of 46 consecutive hours of calm.

Whenever the temperature reached −42° a dense ground fog almost invariably formed over the city. The fog persisted and thickened as the temperature dropped lower and continued until the thermometer rose to about −38° at which point it thinned out to some extent. The highest temperature at which dense fog prevailed was −37°. There were 12 days with minimum temperature −42° or lower. Dense fog occurred on 10 of these days. Light fog was noted on 5 other days. It was interesting to observe the manner in which the fog froze and formed frost crystals on all exposed objects. The telephone wires, trees, and fences became festooned with frost flowers and were very picturesque. This coating of ice flowers often formed an inch or more in thickness and

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remained until shaken off by the rapid vibrations of the wires or was blown off the trees by the wind. The layer of fog was shallow, often only 40 or 50 feet thick. On the streets visibility was restricted to 50 yards while, from the observation platform on the roof, Mt. McKinley, 160 miles away, often was visible. Ice in the river averaged 43 inches thick on the 31st of January. It is interesting to note that Admiral Byrd, in his book "Little America" mentions but 2 months with mean temperatures lower than the January mean at Fairbanks.

February began with mild weather and a low barometer. The maximum temperature of 28° occurred on the 8th and the minimum −49° on the 23d. A great high-pressure area extended over the interior of Alaska late in the month. On the 27th the barometer reached 31.09 inches and remained above 31 inches for 26 hours. The minimum temperature at this time was −45° and the maximum −22°. On 12 days the maximum was zero or lower and on 20 days the minimum was below zero. The average temperature for the coldest 7-day period was −18°. The mean for the month was −6.8° which is 6.9° below normal. Ice in the river averaged 53 inches in thickness at the close of the month.

The cold wave which began on February 18 continued over into March. The minimum temperature for the month, −35°, occurred on the 1st. The mean for the month, 8.3°, is 2° below normal. On the 14th the temperature rose above 32° for the first time since October 23. The barometer fell to 28.97 inches on the 15th and the temperature went up to 45°. Six days previous the barometer registered 30.8 inches. When the storm center arrived the temperature rose from −15° on the 14th to 45° on the 15th. Ice in the river averaged 56.5 inches in thickness on the 13th of March, which is the greatest thickness ever recorded at this station. The mean temperatures for the past 5 months had now been −8.7 and for the past 6 months, −2.4°.

The minimum temperature for April was −5° and the mean 32.1°. The hours of sunlight on the 1st amounted to 13.6 and on the 30th to 16.9. The snow now slid off the house tops and that on the ground began melting. The top layer of soil began thawing and pools of icy water covered the land. The last dogsled was seen on the streets April 19 and this was also the date the first airplane had the skii landing gear removed and began operating on wheels. Winter was over. Late in April the mosquitoes began to appear. Migratory birds were first observed on May 3. Pussy willows appeared and a few crocus and other flowers were observed May 1. The ice broke up in the Tanana River on May 8. Buds on the deciduous trees began opening May 22, and the last heavy frost of spring occurred on June 9.

Record of daily minimum temperatures during the 5 winter months of 1932–33

Number of days	32° or lower	20° or lower	10° or lower	0° or lower	−10° or lower	−20° or lower	−30° or lower	−40° or lower	−50° or lower	−60°
November	30	30	30	30	23	12	2	------	------	------
December	31	31	30	30	22	14	12	4	------	------
January	31	30	28	28	26	24	20	15	3	1
February	28	27	27	21	15	13	11	6	------	------
March	31	29	26	20	14	7	2	------	------	------
Total days	151	147	141	129	100	70	47	25	3	1

Comparative monthly temperatures for Alaska and for selected stations in Canada and northern United States during the winter of 1932–33

	November			December			January			February			March			Mean for 5 months
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	
Greenville, Maine	54	−3	34.9	51	−10	23.6	42	−9	22.1	44	−11	19.5	46	−6	22.4	24.5
Boston	66	8	42.8	66	0	38.1	60	9	37.8	66	9	33.7	60	11	35.7	37.6
Albany, N.Y.	58	9	37.8	63	−7	31.8	56	5	34.6	57	3	29.1	57	8	33.0	33.3
Washington	68	18	44.7	68	14	39.6	68	20	42.6	68	14	38.4	74	20	43.0	41.7
Chicago	63	17	37.2	58	−4	28.8	57	16	36.7	56	−19	26.2	69	6	35.4	32.9
Duluth	62	−10	25.7	45	−23	12.0	42	−15	17.6	39	−33	6.8	44	−13	24.0	17.2
Devils Lake	51	−10	23.6	48	−20	11.0	39	−13	9.5	44	−35	5.8	60	−8	25.8	15.1
Havre	60	−10	31.6	54	−30	19.8	53	−21	21.6	59	−32	16.0	68	−16	35.0	24.8
Miles City	60	−3	34.5	56	−26	17.0	57	−23	20.4	48	−35	15.3	70	6	37.1	24.9
Yellowstone Park	53	4	32.2	43	−29	11.9	37	−7	19.2	37	−40	10.2	51	0	28.4	20.4
Grand Junction	61	15	39.3	51	0	22.3	44	−6	20.2	55	−21	16.5	74	22	43.3	28.3
Spokane	58	26	42.0	54	1	26.9	48	11	31.8	46	−17	23.3	57	23	40.2	32.8
Doucet, Quebec	44	−35	17.5	41	−48	8.2	36	−44	7.0	35	−52	2.9	45	−36	12.8	9.7
Cochran, Ontario	45	−12	20.8	47	−27	11.0	34	−29	6.2	34	−33	5.7	42	−16	15.4	11.8
Le Pas, Manitoba	50	−25	11.0	33	−32	−3.5	36	−38	−7.6	36	−40	−6.3	52	−28	11.6	1.0
Prince Albert, Saskatchewan	51	−12	15.9	38	−31	2.2	38	−38	−4.0	43	−40	−1.7	44	−33	15.7	5.6
Winnipeg	46	−20	18.5	39	−34	2.7	33	−31	2.3	39	−42	−1.9	48	−19	17.1	7.7
Juneau	43	11	31.8	40	9	27.1	45	7	24.0	42	13	28.6	49	9	32.6	28.8
Nome	35	−13	6.0	39	−22	13.2	28	−36	−6.7	39	−28	2.6	28	−22	7.2	4.5
Fairbanks	19	−30	−8.2	27	−47	−13.1	17	−60	−23.5	28	−49	−6.8	45	−35	8.3	−8.7

TWO GOOD BOOKS ON METEOROLOGY

(1) *The Drama of the Weather*, by Sir Napier Shaw, Cambridge University Press, 1933.

(2) *A Short Course in Elementary Meteorology*, Fourth edition (completely revised), by W. H. Pick, London: His Majesty's Stationery Office, 1933.

(1) Naturally the publishers of Sir Napier Shaw's great 4-volume Manual of Meteorology, written for the High Priests, were insistent that he produce something inspiring for the layman. That is why "Th Drama of the Weather" came to be written, a finely printed, beautifully illustrated book cram-full of information with here and there a touch of delightful humor. And with all its world of facts there is in this book neither *sin* nor *cosin* from cover to cover, nor any other mathematical symbol or function whatsoever. What a delight it is to the novice, and yet a store of knowledge on which even the longest initiated can draw with pleasure and profit.

(2) The second of these books is an old and honored friend from the Meteorological Office, London, grown a bit more portly from attending every new banquet worth while. On this fourth visit he tells us all he did before, concisely and accurately, and adds something besides, especially in regard to map construction and forecasting. One can see, too, that here he wisely follows the biblical injunction: "Prove all things: hold fast that which is good."

Nor does this friend, either, puzzle us with mathematical equations, save a few of the simplest that he just has to use when talking about the upper air—that is another reason, in addition to reliability, why he is welcome everywhere.—*W. J. H.*

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING NOVEMBER 1933

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged above normal for November at Washington and Madison and close to normal at Lincoln.

Table 2 shows a deficiency in the total solar and sky radiation received on a horizontal surface at Washington and Pittsburgh, and an excess at all other stations for which normals have been computed.

Turbidity measurements were obtained on November 17th only, and these show that the sky was remarkably free from dry dust on that day.

Polarization measurements obtained at Washington on 5 days give a mean of 57 percent with a maximum of 63 percent on the 10th. At Madison, measurements on 2 days give a mean of 64 percent with a maximum of 65 percent on the 20th. The values for Washington are close to the November normals, while those at Madison are somewhat below normal.

TABLE 1.—*Solar radiation intensities during November 1933*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D.C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A.M.					P.M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	1.0[1]	2.0	3.0	4.0	5.0	e
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
Nov. 7	5.56	0.60									5.36
Nov. 15	1.32			1.19							1.19
Nov. 16	1.37	.85	1.02	1.15	1.28			1.19			1.32
Nov. 17	1.88	.79	.90	1.12	1.30						1.96
Nov. 20	4.37	.68	.80	.98	1.18						4.17
Nov. 25	3.99	.76	.87	1.01	1.24						4.17
Nov. 27	2.26	.98	1.10	1.25	1.35						2.06
Means		.77	.94	1.12	1.27			(1.19)			
Departures		+.01	+.07	+.11	+.08			+.19			

TABLE 1.—*Solar radiation intensities during November 1933*—Con.

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A.M.					P.M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	1.0[1]	2.0	3.0	4.0	5.0	e
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
Nov. 3	2.87			1.29							2.7
Nov. 16	1.07	1.06	1.18	1.35	1.43		1.40				577
Nov. 20	4.17				1.20			0.65			1.6
Nov. 27	3.15							1.10			5.1
Means		(1.06)	(1.18)	(1.32)	(1.32)		(1.40)	(.88)			4.4
Departures		+.28	+.16	+.17	+.02		+.04	−.25			

LINCOLN, NEBR.

Nov. 1	11.38	0.76	0.86	1.02	1.19						11.81
Nov. 2	4.75								1.16	1.04	3.81
Nov. 3	3.30	.82	.91	1.14	1.39		1.39	1.23	1.09	.99	4.37
Nov. 6	2.87	.79	.92	1.11	1.31		1.30	1.12	1.01	.84	3.30
Nov. 7	2.62	1.08	1.20	1.34					1.15		2.36
Nov. 8	3.81	.77	.91	1.04	1.37		1.38				4.37
Nov. 9	2.36						1.44	1.26	1.15	1.03	2.26
Nov. 10	3.99	.88	1.00	1.09	1.29			1.13	.99	.87	5.36
Nov. 11	4.95	.95	1.14	1.26							5.79
Nov. 14	3.81	1.06	1.18								3.30
Nov. 16	2.06	.97	1.08	1.21	1.36						2.62
Nov. 17	4.95						1.34	1.20	1.07	.97	3.81
Nov. 20	3.30	.96	1.05	1.19	1.37						4.57
Nov. 21	3.99	.84	.99	1.21							3.81
Nov. 27	3.15	.93	1.09	1.20				1.14	1.01	.92	4.37
Nov. 29	3.63			.95				1.00	.85	.73	5.16
Means		.90	1.03	1.15	1.33		1.37	1.15	1.05	.92	
Departures		±.00	+.01	−.02	−.01		−.02	−.03	+.01	±.00	

BLUE HILL, MASS.

Nov. 1	4.8			1.11	1.28		1.30	1.20			4.5
Nov. 2	5.0			.97	1.15						6.3
Nov. 4	3.9				1.40		1.39	1.21			2.7
Nov. 5	2.0			1.26	1.40		1.42		1.09		1.5
Nov. 8	4.6							1.12			2.5
Nov. 11	2.4						1.30				1.9
Nov. 12	3.4				1.30		1.30	1.23			1.6
Nov. 15	1.6				1.36						1.1
Nov. 16	1.3			1.39	1.42		1.41	1.27	1.12		1.0
Nov. 17	1.8				1.35						1.5
Nov. 19	2.3						1.38	1.29	1.12		1.8
Nov. 20	3.9							1.20	1.05		2.3
Nov. 21	1.4						1.28	1.22			3.1
Nov. 23	4.2				1.22						4.4
Nov. 25	3.4			1.11	1.22						3.2
Nov. 27	4.0						1.18	1.01	.86	0.73	2.2
Nov. 29	3.7						1.26				3.5
Nov. 30	4.8			.80	.94						5.7
Means				1.11	1.28		1.31	1.19	1.05	(.73)	

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Gainesville	Miami	New Orleans	Riverside	Blue Hill
	Gram calories per square centimeter														
1933	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Oct. 29	255	202	273	237	213	303	158	54	173	363	221	328	221	311	281
Nov. 5	117	107	271	78	141	355	69	29	295	389	284	411	293	359	184
Nov. 12	190	171	229	140	162	299	103	23	257	273	332	371	283	310	66
Nov. 19	163	139	200	162	131	289	188	20	227	315	262	338	[1] 228	314	168
Nov. 26	200	130	166	112	155	256	103	18	206	259	278	247	245	232	160
	Departures from weekly normals														
Oct. 29	+5	+16	+32	+96	+35	−19	+2		−42	+34	−17	−16			
Nov. 5	−111	−57	+29	−41	−10	+61	−59		+97	+57	+33	+68			
Nov. 12	−7	+34	+16	+34	+32	+32	−19		+86	−45	+112	+19			
Nov. 19	−25	+10	−10	+60	+12	+45	+63		+71	−1	+51	+13			
Nov. 26	+29	+2	−27	+16	+45	+41	−4		+61	−43	+65	−50			
	Accumulated departures on Dec. 2														
	+6,804	−1,407	+5,796	+14,805	+9,884	+10,710	−1,778		+2,520	+9,261		−4746			

[1] 6-day mean.

TABLE 3.—*Solar radiation measurements, and determinations of atmospheric turbidity factor, β, Washington, D.C., November 1933*

[Values in italics have been interpolated]

Date and solar hour angle	Solar altitude, h.	Air mass, m.	I_m	I_y	I_r	β	Blueness of sky	Notes: (skylight polarization, P.) clouds, etc.)
Nov. 17			*gr. cal.*	*gr. cal.*	*gr. cal.*			
3:47 a	11-28	4.91	0.799	*0.648*	0.549	0.030		
3:43 a	12-06	4.68	.815	.652	*.551*	.030		
3:35 a	13-22	4.26	.840	*.684*	.577	.040		
3:30 a	14-05	4.05	.888	.686	*.580*	.030		
3:20 a	15-35	3.68	.969	.734	*.621*	.020		
3:16 a	16-10	3.55	.981	*.737*	.624	.020		
2:10 a	24-37	2.39	1.181	*.887*	.691	.020		
2:06 a	25-01	2.37	1.181	.844	*.698*	.020		
0:19 a	31-56	1.89	1.308	.916	*.737*	.020		
0:14 a	32-01	1.88	1.296	*.916*	.738	.020	5	P=57.5

Solar radiation measurements obtained at the Blue Hill Meteorological Observatory of Harvard University during November 1933

[I_m=intensity in the whole spectrum; I_y=intensity transmitted by yellow glass screen OG_1; I_r=intensity transmitted by red glass screen RG_2]

Date and solar hour angle	Solar altitude, h.	Air mass, m.	I_m	I_y	I_r	Sky conditions; clouds, haze (hz), smoke (smk), visibility (v), wind, etc.
Nov. 5	° ′		*gr.cal.*	*gr.cal.*	*gr.cal.*	
0:02, p.m.	32 04	1.88	1.390	1.017	0.810	Few Ci; v 8-9; WNW-4.
Nov. 8						
3:27, p.m.	14 20	3.99	.976	.747	.598	2 Ci, 1 Acu, 2 Stcu; v 9; W-6.
Nov. 11						
1:23, a.m.	27 23	2.17	1.300	.958	.777	1 Cu; v 8; W-5.
Nov. 12						
0:14, p.m.	29 58	2.00	1.197	.900	.742	Few Frcu; v 8-9; NW-5.
2:34, p.m.	20 22	2.85	1.238	.954	.770	Few Cist, few Frcu; v 8-9; NW-4.
2:48, p.m.	18 40	3.10	1.220	.950	.760	
Nov. 16						
1:35, a.m.	25 16	2.33	1.418	1.057	.864	Few Frcu; v 9; W-5.
0:15, p.m.	28 56	2.06	1.413	1.053	.842	No clouds; v 9; W-4.
3:03, p.m.	15 52	3.70	1.156	.904	.752	Few Cu; v 9; W-4.
Nov. 19						
2:56, p.m.	16 09	3.57	1.148	.914	.711	Few Ci, Frcu; v 9; W-4-5.
Nov. 21						
2:01, a.m.	19 39	2.96	1.287	.945	.747	Few Ci, 4 Acu; v 6-7; SE-2.
Nov. 23						
1:05, a.m.	24 21	2.42	1.107	.824	.762	Few Cu; hz; v 6-7; NNW-3.
Nov. 25						
1:04, a.m.	25 19	2.33	1.251	.918	.729	1 Ci, 1 Acu, 1 Stcu; v 8; W-1.
Nov. 27						
0:32, p.m.	26 03	2.28	1.089	.805	.657	2 Acu, 5 Stcu; lt. hz; WNW-6.
Nov. 28						
2:02, a.m.	20 30	2.84	.976	.747	.612	Few Acu; hz; v 7; WSW-3.
Nov. 29						
0:14, a.m.	26 13	2.26	1.202	.900	.711	1 Acu; hz; SW-1.
Nov. 30						
1:56, a.m.	20 42	2.81	.792	.612	.513	Few Ci; dense hz; SWW-7.
0:04, a.m.	26 07	2.27	.827	.634	.536	Few Cu; dense hz; SW-8.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent United States Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Perkins, and Mount Wilson observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1933	h. m.	°	°	°			
Nov. 1 (Naval Observatory)	12 4	+78.0	90.6	+7.5	------	39	39
Nov. 2 (Naval Observatory)	12 30		No spots				
Nov. 3 (Naval Observatory)	12 53		No spots				
Nov. 4 (Naval Observatory)	11 15		No spots				
Nov. 5 (Mount Wilson)	11 3		No spots				
Nov. 6 (Naval Observatory)	13 50		No spots				
Nov. 7 (Mount Wilson)	11 12		No spots				
Nov. 8 (Naval Observatory)	12 18		No spots				
Nov. 9 (Mount Wilson)	11 19		No spots				
Nov. 10 (Naval Observatory)	11 9		No spots				
Nov. 11 (Naval Observatory)	10 53		No spots				
Nov. 12 (Naval Observatory)	10 47		No spots				
Nov. 13 (Mount Wilson)	11 24		No spots				
Nov. 14 (Naval Observatory)	10 41		No spots				
Nov. 15 (Naval Observatory)	12 50		No spots				
Nov. 16 (Naval Observatory)	12 0		No spots				
Nov. 17 (Naval Observatory)	11 56		No spots				
Nov. 18 (Mount Wilson)	10 14		No spots				
Nov. 19 (Mount Wilson)	11 10		No spots				
Nov. 20 (Naval Observatory)	12 20		No spots				
Nov. 21 (Naval Observatory)	13 10		No spots				
Nov. 22 (Naval Observatory)	11 46		No spots				
Nov. 23 (Naval Observatory)	10 58		No spots				
Nov. 24 (Mount Wilson)	11 20	+25.0	94.8	+8.0	------	7	7
Nov. 25 (Naval Observatory)	11 30		No spots				
Nov. 26 (Naval Observatory)	11 38		No spots				
Nov. 27 (Naval Observatory)	12 29		No spots				
Nov. 28 (Naval Observatory)	12 13		No spots				
Nov. 29 (Naval Observatory)	11 34		No spots				
Nov. 30 (Naval Observatory)	12 15		No spots				
Mean daily area for November							2

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR NOVEMBER 1933

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

November 1933	Relative numbers	November 1933	Relative numbers	November 1933	Relative numbers
1	10	11	0	21	0
2	0	12	0	22	------
3	0	13	------	23	0
4	8	14	0	24	------
5	0	15	0	25	------
6	0	16	0	26	0
7	0	17	0	27	0
8	0	18	0	28	
9	0	19	0	39	0
10	------	20	0	30	0

Mean: 25 days=0.7.

AEROLOGICAL OBSERVATIONS

[Aerological Division, W. R. Gregg, in charge]

By L. T. SAMUELS

Free-air temperatures during November averaged below normal at the eastern stations and at Pembina (table 1). The departures at Boston were of considerable magnitude. At Omaha, Dallas and San Diego, the temperatures averaged somewhat above normal. The relative humidity departures in general were of opposite sign to those of temperature.

Resultant free-air wind velocities were generally above normal except on the Pacific Coast where they were below normal (table 2). Resultant free-air wind directions were close to normal over the entire country except on the Pacific Coast where marked differences occurred. Of special interest in this connection is the change from a northerly component in the resultant wind over California at the 3,000-meter level to southerly at the 4,000-meter level. The normal at both these levels is northerly.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during November 1933*

TEMPERATURE (° C.)

Altitude (meters) m.s.l.	Boston, Mass.[1] (6 meters)		Cleveland, Ohio[2] (246 meters)		Dallas, Tex.[3] (146 meters)		Norfolk, Va.[4] (3 meters)		Omaha, Nebr.[5] (300 meters)		Pembina, N.Dak.[6] (243 meters)		Pensacola, Fla.[4] (2 meters)		San Diego, Calif.[4] (9 meters)		Washington, D.C.[4] (2 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	2.2	(7)	1.9	(7)	9.8	(7)	5.6	−3.0	1.3	(7)	−6.8	(7)	13.5	−0.1	15.7	−1.7	2.2	−3.0
500	0.1	(7)	2.4	(7)	13.2	(7)	5.7	−3.0	2.5	(7)	−6.4	(7)	13.4	+0.1	18.0	+0.9	2.0	−3.1
1,000	−1.9	−3.5	0.3	−0.5	12.6	+2.8	3.6	−2.9	4.2	+1.2	−6.5	−2.2	11.8	−0.1	18.7	+1.9	1.0	−2.9
1,500	−3.2	−4.3	−1.5	−1.1	11.5	+3.2	------	------	3.6	+1.4	−6.1	−1.6	------	------	------	------	------	------
2,000	−4.9	−5.3	−2.0	+0.2	9.4	+2.9	0.1	−2.4	2.3	+1.9	−7.0	−1.0	7.7	−1.3	13.4	+1.5	−3.1	−3.8
2,500	−6.5	−4.8	−4.0	+0.1	6.7	+2.3	------	------	0.1	+2.0	−9.1	−1.0	------	------	------	------	------	------
3,000	−8.5	−4.7	−6.1	+0.4	4.0	+2.0	−3.8	−3.4	−2.1	+2.4	−11.2	−0.5	2.1	−2.5	8.3	+1.7	−6.0	−3.7
4,000	−13.4	−4.8	−11.4	−0.1	−1.7	+1.6	------	------	−7.8	+2.2	−16.5	−0.3	−3.7	−2.5	0.6	+0.9	------	------
5,000	−19.2	−4.2	−18.0	−0.7	−8.0	+1.2	------	------	−13.8	+1.8	−22.8	−0.8	−9.9	−2.5	------	------	------	------

RELATIVE HUMIDITY (PERCENT)

Surface	73	(7)	78	(7)	82	(7)	74	−1	73	(7)	90	(7)	74	−6	64	+4	71	−3
500	73	(7)	76	(7)	65	(7)	66	+2	69	(7)	83	(7)	68	−5	49	−1	65	0
1,000	72	+8	79	+11	61	+2	62	+2	61	+3	80	+15	64	−3	31	−7	60	0
1,500	69	+10	76	+17	52	0	------	------	54	+1	68	+10	------	------	------	------	------	------
2,000	67	+14	61	+8	46	−1	56	+2	45	−5	62	+7	57	+2	24	−5	58	+4
2,500	64	+13	57	+8	40	−2	------	------	43	−6	63	+8	------	------	------	------	------	------
3,000	61	+11	56	+8	34	−4	47	+10	43	−7	60	+5	52	+7	21	−5	50	+9
4,000	57	+10	53	+9	29	−5	------	------	45	−6	56	+1	45	+4	20	−4	------	------
5,000	58	+13	53	+7	23	−9	------	------	48	+1	55	−3	41	+4	------	------	------	------

Times of observations: Weather Bureau, 5 a.m.; Navy, 7 a.m.; and M.I.T., 8 a.m. (E.S.T.).

[1] Airplane observations made by Massachusetts Institute of Technology; departures based on normals obtained from kite observations made at Blue Hills Meteorological Observatory.

[2] Temperature departures based on normals determined by extrapolating latitudinally those of Royal Center, Ind., and Due West, S.C. Humidity departures based on normals of Royal Center, Ind.

[3] Temperature departures based on normals determined by interpolating latitudinally those of Groesbeck, Tex., and Broken Arrow, Okla. Humidity departures based on normals of Groesbeck, Tex.

[4] Naval air stations.

[5] Temperature and humidity departures based on normals of Drexel, Nebr.

[6] Temperature departures based on normals determined by extrapolating latitudinally those of Ellendale, N.Dak., and Drexel, Nebr. Humidity departures based on normals of Ellendale, N.Dak.

[7] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a.m. (E.S.T.) during November 1933*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m.s.l.	Albuquerque, N. Mex. (1,554 meters)		Atlanta, Ga. (309 meters)		Bismarck, N.Dak. (518 meters)		Brownsville, Tex. (7 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Chicago, Ill. (192 meters)		Cleveland, Ohio (245 meters)		Dallas, Tex. (154 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	344	1.6	288	2.3	304	3.3	326	0.3	190	1.6	294	5.1	276	2.4	228	3.2	109	0.3	253	3.5	319	1.8	24	3.9
500	------	------	290	5.8	------	------	141	5.1	223	4.1	------	------	274	5.4	246	6.4	239	1.8	------	------	340	4.7	43	7.2
1,000	------	------	290	9.7	308	11.5	166	5.2	262	5.6	------	------	283	8.4	262	8.2	259	3.7	260	7.3	295	4.2	59	5.5
1,500	------	------	295	9.4	312	13.3	183	3.8	282	8.5	------	------	279	13.3	265	10.4	286	6.0	287	12.0	293	4.2	34	4.5
2,000	307	1.7	291	10.3	306	12.8	199	2.4	288	11.0	292	7.7	284	14.5	271	12.2	294	7.0	294	14.9	303	6.5	12	4.7
2,500	298	3.6	282	12.2	303	12.4	260	1.6	291	14.6	306	11.6	287	16.7	284	14.3	295	7.0	295	16.1	299	10.4	360	3.8
3,000	287	5.4	282	13.0	310	11.3	335	3.6	288	16.7	310	11.3	------	------	------	------	308	7.3	294	15.9	294	12.3	346	3.4
4,000	299	7.5	286	16.9	------	------	288	4.2	------	------	304	8.9	------	------	------	------	301	9.3	310	14.5	------	------	302	6.0
5,000	309	9.0	------	------	------	------	295	4.0	------	------	269	9.7	------	------	------	------	------	------	------	------	------	------	------	------

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a.m. (E.S.T.) during November 1933*—Continued

Altitude (meters) m.s.l.	Los Angeles, Calif. (217 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (83 meters)		New Orleans, La. (2 meters)		Oakland, Calif. (8 meters)		Oklahoma City, Okla. (402 meters)		Omaha, Nebr. (306 meters)		Phoenix, Ariz. (338 meters)		Salt Lake City, Utah (1,294 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Washington, D.C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	359	0.8	189	0.6	262	0.7	34	1.2	31	1.1	262	1.3	311	0.7	90	1.8	141	3.5	53	1.0	153	1.5	297	1.9
500	28	.8	246	.2	272	4.7	40	1.7	30	4.3	222	2.8	294	3.3	79	3.8			140	1.1	221	4.1	289	5.9
1,000	44	1.7	137	1.0	287	8.3	321	2.5	28	4.0	256	5.2	306	9.0	76	3.2			313	2.6	228	5.4	287	9.5
1,500	56	1.5	117	2.5	288	8.9	316	3.2	19	1.6	271	4.2	306	11.5	87	2.0	165	2.6	316	4.4	250	5.1	293	12.4
2,000	92	1.5	61	1.7	298	10.1	294	6.3	356	1.6	289	7.0	300	12.9	99	.3	228	1.3	320	7.3	243	7.5	293	13.1
2,500	59	.9	13	2.4	302	11.8	300	7.6	350	2.0	291	8.4	300	14.0	179	.3	304	2.3	323	9.1			292	14.5
3,000	30	1.9	300	3.7	307	9.8	310	10.4	5	1.0	292	9.7	298	16.4	273	1.6	302	3.9	310	12.2			271	11.8
4,000	189	2.2	351	3.0					168	.9	285	10.6	285	12.4	274	3.7	315	8.9						
5,000									95	3.3					354	2.7	335	8.2						

RIVERS AND FLOODS

By RICHMOND T. ZOCH

[River and Flood Division, Montrose W. Hayes, in charge]

There were no floods in the rivers of the United States during November 1933.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDonald, in charge]

NORTH ATLANTIC OCEAN

By W. F. McDONALD

The pressure situation.—High pressure was exceptionally persistent during November 1933 from the Azores to the Greenland Sea. The highest pressure over any part of the North Atlantic, (30.61 inches), was reported on the 9th by several ships in the vicinity of the Azores.

The major extra-tropical cyclones remained for the most part in high latitudes. The lowest recorded pressure was 28.19 inches on the 29th at Julianehaab, Greenland. The American Steamship *Quaker City* reported the lowest barometer reading at sea, 28.49 inches, on the 28th near 49°N., 45°W.

Average pressure for the month was below normal over the western Atlantic, especially in the region of Labrador and Davis Strait where the deficiency was more than two tenths of an inch. There was also a smaller deficiency in average pressure over the Iberian Peninsula. Elsewhere, Atlantic pressures were above normal with the greatest excess eastward from Iceland. (See table 1.)

Cyclones and gales.—At the opening of the month and throughout the first 10 days, storminess was mainly confined to the western Atlantic, south of the fiftieth parallel. Gales were mostly moderate to fresh, however, and in only two cases reached whole gale force, south of the Grand Banks.

From the 10th to the end of the month, gales were more widespread and in general more severe, and in the last decade winds of force 12 were encountered by two ships near mid-ocean on the main transatlantic route, in the first instance by the German Steamship *Europa* on the 22d, and again by the Danish Steamship *Maine* on the 26th. Between the 11th and 15th, on the 21st and 22d, and on the 27th and 28th winds of whole gale to storm force were experienced by a number of ships on the northern routes. (See Table of Ocean Gales and Storms.)

The increased intensity of storm conditions at the middle of the month brought about the only marine casualty of any importance which has been reported. The British Steamship *Saxilby*, bound eastward from Newfoundland to the British Isles on the 15th, called for assistance in latitude 51°50′ N., longitude 19°15′ W., and stated that the crew was taking to the ship's boats in heavy seas. Several steamers responded to this distress call but no trace of ship or crew could be found.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, November 1933*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.41		30.08	3	28.19	29
Reykjavik, Iceland	29.75	+0.13	30.49	2	29.08	11
Lerwick, Shetland Islands	29.95	+.25	30.47	18	29.44	14
Valencia, Ireland	29.97	+.08	30.41	3	29.14	15
Lisbon, Portugal	29.95	−.09	30.28	1	29.43	17
Madeira	30.05	+.04	30.46	1	29.70	18
Horta, Azores	30.21	+.08	30.58	9	29.78	27
Belle Isle, Newfoundland	29.65	−.23	30.16	22	28.80	15
Halifax, Nova Scotia	29.90	−.05	30.38	29	29.28	15
Nantucket	29.93	−.12	30.47	17	29.14	27
Hatteras	30.07	−.04	30.61	17	29.55	26
Bermuda	30.04	−.04	30.36	29	29.66	7
Turks Island	29.94	−.05	30.06	17, 21, 29, 30	29.74	1, 2
Key West	30.05	+.03	30.36	16	29.70	4
New Orleans	30.15	+.05	30.51	16	29.76	2
Cape Gracias, Nicaragua	29.89	+.01	29.96	10, 11, 17	29.76	1

NOTE.—All data based mainly on a.m. observations, with departures compiled from best available normals related to time of observations, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

This casualty was caused by a deep cyclonic disturbance that, on the 14th, was central south of Iceland moving southeastward. After reaching Ireland on the 15th, the disturbance crossed the Bay of Biscay to the Iberian Peninsula, which it reached on the 18th and thereafter appeared to divide into two parts, one of which moved back again toward Ireland, greatly weakened in intensity. The movement of this disturbance between the 14th and 17th, within which time the *Saxilby* foundered, is shown in charts VIII to XI.

Tropical cyclones were a minor feature of the weather of the month. Between the 1st and 7th a moderate disturbance moved on an irregular north and northeastward course from the middle Caribbean region towards Bermuda but no wind stronger than a fresh gale has been reported in connection with it. Another weak and short-lived disturbance arose in the western Caribbean on the 15th and on the 16th caused moderate to fresh gales between Jamaica and Central America. More complete notes regarding these tropical disturbances appear elsewhere in this issue.

Fog.—Fog was infrequent during November 1933 on the North Atlantic ship lanes, though reported on 1 or 2 days from Cape Hatteras nearly to the Irish coast. It was most frequently encountered east of Newfoundland where, in one 5-degree square, fog was reported on 6 days.

OCEAN GALES AND STORMS, NOVEMBER 1933

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Arizonan, Am.S.S.	New York	Cristobal	22 24 N.	74 06 W.	Oct. 31	3p, Nov. 1	Nov. 1	29.65	E.	ENE., 7	ENE.	E., 8	
Sundance, Am.S.S.	Wilmington, N.C.	Bremen	43 50 N.	45 59 W.	Nov. 2	3a, 3	Nov. 3	29.36	N.	N., 9	N.	N., 9	N.
Steel Scientist, Am.S.S.	New York	Cristobal	25 20 N.	74 28 W.	Nov. 3	6a, 4	Nov. 4	29.67	ESE.	SE., 6	SE.	ESE., 9	Steady.
Meanticut, Am.S.S.	New Orleans	Bremen	39 38 N.	52 38 W.	Nov. 1	1p, 4	do	29.45	NW.	NW., 9	NW.	NW., 10	N.-NW.
General von Steuben Ger.S.S.	New York	Galway	46 26 N.	52 50 W.	Nov. 5	5a, 5	Nov. 6	29.16	WSW.	WSW., 8	SSW.	SW., 10	WSW.-SSW.
Beemsterdijk, Du.S.S.	Rotterdam	Tampico	32 59 N.	58 18 W.	Nov. 7	2p, 7	Nov. 7	29.57	SE.	S., 5	SSE.	SSE., 8	SSE.-SW.
Caledonia, Br.S.S.	Halifax	Glasgow	46 26 N.	52 33 W.	do	6a, 8	Nov. 8	29.10	E.	SE., 9	SW.	SE., 10	SE.-SSE.
Black Gull, Am.S.S.	Antwerp	New York	50 16 N.	12 42 W.	Nov. 11	6a, 11	Nov. 12	29.73	NW.	NW., 8	NW.	NW., 10	
Meanticut, Am.S.S.	New Orleans	Bremen	48 30 N.	14 07 W.	do	10p, 11	do	29.87	NW.	NW., 10	NNW.	NW., 10	
Frederik VIII, Da.S.S.	New York	Kristiansand	51 10 N.	43 35 W.	Nov. 12	Noon, 13	Nov. 15	29.49	S.	WSW., 10	NNW.	WSW., 10	SW.-WSW.-W.
Holystone, Br.S.S.	Swansea	Montreal	53 28 N.	42 30 W.	Nov. 13	1p, 13	Nov. 13	29.02	W.	WSW., 10	WNW.	NW., 11	WSW.-WNW.
Themisto, Du.S.S.	Montreal	Rotterdam	53 21 N.	39 46 W.	do	2p, 13	do	29.09	S.	S., 10	WNW.	W., 11	S.-W.
United States, Dan.S.S.	Oslo	New York	57 30 N.	24 40 W.	Nov. 14	8p, 14	Nov. 15	28.62	SSE.	WNW., 7	NNW.	WNW., 11	S.-WNW.
West Eldara, Am.S.S.	Rotterdam	Boston	50 46 N.	17 39 W.	do	11a, 14	Nov. 16	29.58	W.	W., 8	N.	NNW., 10	W.
Stephen, Br.S.S.	Norfolk	Para	34 53 N.	73 15 W.	do	4p, 14	Nov. 14	29.46	W.	WSW., 9	W.	WSW., 9	W.-WSW.
Boston City, Br.S.S.	Bristol, England.	Philadelphia	50 47 N.	16 17 W.	do	2p, 15	Nov. 16	29.17	WNW.	NW., 10	N.	NW., 10	WNW.-NNW.
Liberty Glo, Am.S.S.	Rotterdam	Charleston	47 57 N.	16 14 W.	do	8p, 15	do	29.42	SW.	NNW., 10	N.	NNW., 10	
Dinteldijk, Du.M.S.	Cristobal	Liverpool	47 38 N.	15 17 W.	Nov. 15	3a, 16	do	29.38	NW.	NW., 9	NE.	NW., 10	NW.-N.
Cefalu, Hond.S.S.	do	New Orleans	[1] 12 20 N.	[1] 82 25 W.	do	4a, 16	do	29.62	NW.	SE., 8	NE.	SE., 8	S.-E.
Palatia, Ger.M.S.	Mobile	Bremen	[1] 46 51 N.	[1] 35 33 W.	Nov. 17	Mdt., 17	Nov. 18	29.32	S.	S., 8	WNW.	WNW., 9	S.-SSW.-WSW
Examelia, Am.S.S.	Gibraltar	New York	36 19 N.	52 42 W.	Nov. 21	4p, 20	Nov. 21	29.83	W.	SW., 4	NW.	W., 9	SW.-WSW.
Pres. Harding, Am.S.S.	Southampton	do	46 12 N.	43 48 W.	Nov. 20	6p, 21	Nov. 22	29.18	S.	WSW., 6	NW.	WNW., 10	S.-W.-WNW.
Boston City, Br.S.S.	Bristol, England.	Philadelphia	47 10 N.	44 29 W.	Nov. 21	7p, 21	do	29.25	W.	W., 8	NNW.	NNW., 10	W.-NW.
West Eldara, Am.S.S.	Rotterdam	Boston	48 17 N.	47 01 W.	do	8p, 21	do	29.28	NW.	W., 5	NW.	NNW., 11	W.-NW.
Europa, Ger.S.S.	English Channel.	New York	46 30 N.	38 51 W.	do	1a, 22	do	29.22	WSW.	WSW., 9	NW.	NW., 12	WSW.-WNW.
Black Falcon, Am.S.S.	Rotterdam	do	48 26 N.	40 50 W.	do	do	do	29.08	S.	WSW., 9	SW.	NW., 10	SW.-NW.-SW
Caledonia, Br.S.S.	Glasgow	Boston	51 12 N.	40 28 W.	do	4a, 22	Nov. 23	28.78	E.	SE., 7	W.	NW., 11	ESE.-SE.-W.
General von Steuben, Ger.S.S.	Galway	New York	50 42 N.	39 10 W.	Nov. 22	5a, 22	Nov. 22	28.82	SW.	N., 9	NW.	NNW., 11	SW.-N.
City of Dalhart, Am.M.S.	Gibraltar	do	36 24 N.	71 02 W.	do	3p, 22	do	29.84	SW.	SW., 8	SW.	SW., 9	SSW.-SW.
Kenbane Head, Br.S.S.	Montreal	Dublin	48 35 N.	44 52 W.	Nov. 26	8a, 26	Nov. 26	29.19	W.	W., 10	NW.	W., 10	None.
Maine, Dan.S.S.	Harburg, Germany.	Wilmington, N.C.	[1] 46 57 N.	[1] 35 55 W.	do	6p, 26	Nov. 27	29.09	W.	WNW., 10	N.	WNW., 12	Steady.
Spidoleine, Belg.M.S.	Rouen	New York	48 13 N.	28 43 W.	Nov. 27	3a, 27	do	28.55	NW.	SW., 5	NW.	NW., 11	S.-SW.-NW.
Champlain, Fr.S.S.	Plymouth	do	42 20 N.	50 22 W.	Nov. 26	4a, 27	do	29.07	SE.	SSW. 9	W.	SW., 11	S.-SW.
Executive, Am.S.S.	Lisbon	do	37 05 N.	64 10 W.	do	do	Nov. 28	29.45	S.	SSW., 10	WNW.	SW., 11	SSW.-SW.
Syros, Am.S.S.	Rotterdam	Galveston	41 52 N.	22 27 W.	do	Noon, 27	do	29.18	W.	W., 9	NW.	WNW., 10	W.-NW.
Kertosono, Du.S.S.	Gibraltar	Halifax	42 23 N.	60 35 W.	do	4p, 27	Nov. 27	29.21	S.	W., 7	WSW.	SW., 10	None.
Europa, Ger.S.S.	New York	English Channel.	43 15 N.	46 45 W.	Nov. 27	4a, 28	Nov. 28	29.06	SSW.	SW., 8	W.	NW., 10	SW.-NW.
Quaker City, Am.S.S.	Dundee	Boston	49 48 N.	45 50 W.	Nov. 28	8a, 28	Nov. 29	28.49	SE.	SW., 9	NW.	SW., 9	
Spidoleine, Belg.M.S.	Rouen	New York	46 24 N.	38 41 W.	Nov. 29	3p, 29	do	29.17	W.	NW., 10	WNW.	NW., 10	WNW.-NW.
Georgia, Dan.S.S.	Newcastle-on-Tyne.	Norfolk	[1] 57 10 N.	[1] 25 03 W.	Nov. 28	11a, 29	Nov. 30	29.02	SSE.	SSE., 10	WSW.	WNW., 10	SSE.-SW.-WSW.
NORTH PACIFIC OCEAN													
President Cleveland, Am.S.S	Victoria	Yokohama	51 34 N.	163 46 W.	Nov. 1	4p., Nov.	1 Nov. 3	29.43	SSW.	SW., 8	WNW.	WNW, 9	SW-S.
Grays Harbor, Am.S.S.	Seattle	do	51 49 N.	161 16 W.	do	4a., 2	do	29.34	S.	SSW., 8	WNW.	SSW., 9	SSW-W.
Yayoi Maru, Jap.S.S.	Kobe	Portland, Oreg.	40 45 N.	151 45 E.	Nov. 2	10p., 2	do	[2] 29.55	S.	S., 8	W.	SSW., 9	
Hakonesan Maru, Jap. M.S.	Yokohama	Los Angeles	45 02 N.	173 02 E.	Nov. 3	8a., 4	Nov. 4	29.64	SSE.	S., 9	WNW.	S., 9	S.-WNW.
San Pedro Maru, Jap. M.S.	Monterey	Yokohama	35 27 N.	146 38 W.	do	6a., 4	Nov. 5	29.58	SE.	S., 7	SW.	SE., 9	SSE.-S.-SSW.
Michigan, Am. S.S.	Columbia River.	Shanghai	49 30 N.	171 42 E.	Nov. 4	8a., 4	do	29.59	SSE.	W., 6	WSW.	WSW, 10	SSE-W.
President Cleveland, Am.S.S	Victoria	Yokohama	49 23 N	179 03 E.	do	6p., 4	do	29.77	S.	S., 9	WSW.	S., 9	S-WNW.
Teiyo Maru, Jap.M.S.	Los Angeles	Hakodate	46 15 N.	161 55 E.	Nov. 7	8a., 7	Nov. 8	29.17	SSE.	SSE., 10	W.	SSE, 10	SSE-W.
President Cleveland, Am.S.S.	Victoria	Yokohama	43 55 N.	157 00 E.	do	11a., 7	do	29.35	SE.	SE., 10	WNW.	WSW., 11	SE.-NW.
Yayoi Maru, Jap.S.S.	Kobe	Portland, Oreg.	49 30 N.	179 30 W.	do	5a., 8	do	[2] 29.61	SSE.	SSE., —	WNW.	SSE., 8	
Michigan, Am.S.S.	Columbia River.	Shanghai	47 05 N.	160 54 E.	do	5p., 7	Nov. 9	29.38	SSE.	S., 10	W.	S., 10	SSE.-S.-WSW.
Grays Harbor, Am.S.S.	Seattle	Yokohama	49 52 N.	170 22 E.	Nov. 8	6a., 10	Nov. 10	29.31	SSE.	WSW., 8	N.	W., 10	WSW.-WNW.
Ohioan, Am.S.S.	Los Angeles	Balboa	15 30 N.	95 00 W.	Nov. 10	9a., 10	Nov. 11	29.84	NE.	N., —	NW.	NW., 9	N.
Charcas, Am.S.S.	Champerico	Los Angeles	15 14 N.	94 38 W.	do	4a., 11	do	29.87	NNW.	NNE., 7	NNE.	N., 8	NNE.-ENE.
San Pedro Maru, Jap. M.S.	Yokohama	San Francisco.	44 48 N.	155 15 W.	do	6p., 10	Nov. 12	30.08	NNE.	NNE., 8	NW.	NNE., 8	
Seattle, Am.S.S.	Philippine Islands.	Los Angeles	20 00 N.	135 30 E.	do	4p., 11	do	29.19	NW.	SW., 8	SSE.	SSE., 9	WSW.-SW.-SSW.
Point Sur, Am.S.S.	Balboa	do	14 39 N.	94 53 W.	Nov. 11	8p., 11	do	29.85	NW.	N., 7	NE.	N., 9	NNW.-N.
W. S. Miller, Am.S.S.	Los Angeles	Balboa	15 20 N.	95 30 W.	do	1a., 12	do	29.86	NE.	NNW., 9	NNW.	NNW., 9	NE.-NNW
Yayoi Maru, Jap.S.S.	Kobe	Portland, Oreg.	49 25 N.	139 10 W.	Nov. 13	6a., 13	Nov. 14	[2] 29.67	SE.	SE., —	S.	SE., 9	

[1] Position approximate.
[2] Barometer uncorrected.

OCEAN GALES AND STORMS, NOVEMBER 1933—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
			° ′	° ′				*Inches*					
Ward, Am.M.S.	Shanghai	Los Angeles	39 24 N.	171 26 E.	Nov. 13	Mdt., 13	Nov. 13	29.39	SE.	W., 5.	SW.	S., 8.	None.
Empress of Asia, Br.S.S.	Vancouver	Yokohama	51 48 N.	151 12 W.	Nov. 14	6a., 14	Nov. 14	28.98	N.	N., 9.	NNW.	N., 9.	N.-NNW.
President Jackson, Am. S.S.	Victoria	do	52 03 N.	149 16 W.	do	8a., 14	do	28.80	NW.	ESE., 3.	WNW.	NW., 9.	SE.-ESE.-NW.
Illinois, Am.S.S.	Niigata, Japan.	San Francisco.	47 15 N.	169 12 W.	Nov. 13	1p., 14	Nov. 15	28.78	ESE.	NE., 11.	NNW.	NE., 11.	ENE.-NE.-NNE.
Empress of Asia, Br.S.S.	Vancouver	Yokohama	52 00 N.	162 06 W.	Nov. 15	6a., 15	do	29.06	NE.	NE., 8.	NE.	NE., 9.	Steady.
President Jackson, Am. S.S.	Victoria	do	52 02 N.	160 45 W.	do	Noon, 15	do	28.78	NNE.	NE., 6.	N.	NNE., 9.	NE.-NNE.
Oregonian, Am.S.S.	Balboa	Los Angeles	15 04 N.	94 27 W.	Nov. 16	4p., 16	Nov. 16	29.92	NNW.	N., 9.	N.	N., 9.	
Grays Harbor, Am.S.S.	Seattle	Yokohama	39 18 N.	144 00 E.	do	10p., 16	Nov. 17	29.16	SE.	SE., 8.	WSW.	NW., 11.	SE.-NW.
Ward, Am.M.S.	Shanghai	Los Angeles	41 44 N.	158 35 W.	Nov. 17	4p., 17	Nov. 18	29.66	W.	W., 7.	W.	W., 8.	None.
Hiye Maru, Jap.S.S.	Yokohama	Vancouver	46 09 N.	165 00 E.	Nov. 18	11a., 18	do	28.19	ESE.	SSW., 7.	SSW.	SSW., 11.	ENE.-SSW.
Empress of Asia, Br.S.S.	Vancouver	Yokohama	48 54 N.	167 18 E.	do	10p., 18	Nov. 19	28.70	E.	E., 8.	NW.	E., 9.	E.-NE.
President Jackson, Am. S.S.	Victoria	do	49 04 N.	171 32 E.	do	4a., 19	Nov. 20	28.65	ESE.	Var. 1.	NNW.	NNW., 10	E.-Var.-N.
President Grant, Am. S.S.	Yokohama	Seattle	37 45 N.	145 35 E.	Nov. 19	3p., 19	do	29.74	SE.	E., 8.	NE.	E., 9.	E.-ESE.
Hiye Maru, Jap.S.S.	do	Vancouver	50 03 N.	153 45 W.	Nov. 22	11a., 22	Nov. 23	28.35	N.	N., 4.	SSW.	WSW., 11.	NNE.-N.-W.
Tamaha, Br.S.S.	Shanghai	Los Angeles	40 03 N.	171 09 E.	Nov. 24	2a., 25	Nov. 25	29.97	S.	S., 8.	S.	S., 9.	S.-SW.
Taiyo Maru, Jap.S.S.	Yokohama	Honolulu	[1]34 46 N.	[1]152 48 E.	Nov. 26	2p., 25	Nov. 28	29.76	N.	NE., 6.	ENE.	N., 8.	Steady.
R. J. Hanna, Am.S.S.	Richmond, Calif.	Point Wells	38 52 N.	123 55 W.	Nov. 28	2p., 28	Nov. 29	29.88	NW.	NW., 8.	NNW.	NNW., 10	
Tamaha, Br.S.S.	Shanghai	Los Angeles	40 01 N.	167 42 W.	do	4p., 28	do	30.22	NNE.	ENE., 8.	NE.	ENE., 8.	NE.-ENE.
San Diego Maru, Jap. S.S.	Kobe	San Francisco.	40 20 N.	162 45 E.	Nov. 29	6p., 29	do	29.27	SSE.	SSE., 10.	SW.	SSE., 10.	SSE.-SW.

[1] Position approximate.

NORTH PACIFIC OCEAN, NOVEMBER 1933

By WILLIS E. HURD

Atmospheric pressure.—Winter conditions of atmospheric pressure were fairly well established over the North Pacific Ocean during November 1933. The Aleutian low on the average was central over the western part of the Gulf of Alaska (average pressure at Kodiak, 29.59 inches). Pressures were above normal along the entire American coast, with the point of greatest departure, +.27 inch, at Tatoosh Island, and that of least departure, +.03 at Kodiak. Pressures were slightly lower than normal from the Hawaiian Islands westward to the Philippines.

The North Pacific anticyclone was much disturbed by lows, except off the middle American coast, where it remained unbroken throughout the month. High pressures intruded strongly into the Aleutian area on several days early and late in the month. The highest daily reading was 30.76 inches, reported by a ship in the western Aleutians on the 29th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, November 1933, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow [1]	30.12	+0.13	30.42	7, 8	29.68	12
Dutch Harbor	29.70	+.11	30.48	30	29.00	27
St. Paul	29.70	+.11	30.56	29, 30	28.96	27
Kodiak	29.59	+.03	30.36	5	28.60	23
Juneau	29.89	+.13	30.47	4	29.24	20
Tatoosh Island	30.24	+.27	30.58	12	29.74	27
San Francisco	30.13	+.04	30.32	12	29.71	28
Mazatlan	29.94	+.05	30.02	17	29.84	3
Honolulu	30.00	−.02	30.15	15	29.79	8
Midway Island	30.04	−.04	30.30	4	29.74	30
Guam	29.84	−.02	29.96	19	29.76	11
Manila	29.83	−.06	29.92	16	29.64	2
Naha	30.03	+.05	30.20	6	29.61	1
Chichishima	30.00	+.02	20.20	9	29.60	15
Nemuro	29.99		30.42	10	29.30	16

[1] For 20 days.

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—Storm conditions showed considerable increase in intensity this month over those in October, especially along the northern steamship routes, and in the southeastern tropics. At least 27 days in November had wind forces of 8 or over, and of these, at least 10 days had wind forces of 10 or 11 in some part of the ocean.

The gales of the 1st to 4th occurred principally in northern waters south of the Aleutians. On the 6th and 7th the gale field lay east of northern Japan and south of the Kuril Islands. This storm area moved eastward as far as the one hundred and eightieth meridian, south of the western Aleutians, on the 8th and 9th.

The principal cyclone of the month originated as a typhoon between the Philippines and Guam about the 10th, and on this and the two succeeding days gales of force 8–9 were reported near 20° N., between 130° and 140° E. On the 11th, in 20° N., 135½° E., the lowest reported pressure was 29.19 inches. This cyclone passed near the Ogasawara Islands (Chichishima) on the 15th, and on the 16th was causing gales up to 11 in force off the east coast of central Japan. It crossed the Kurils, then swung eastward, and entered the extreme western Aleutian area where, on the 18th, the Japanese S.S. *Hiye Maru*, reported the lowest pressure reading of the month, 28.19 inches, in 46° N., 165° E., with maximum wind force, 11. The disturbance advanced rapidly into west longitudes during the 18th and 19th, and for 4 days remained central as a deep storm near 50° N., 160° to 150° W. The S.S. *Hiye Maru* was again heavily involved in it on the 22d, when the wind rose to force 11, with lowest pressure 28.35 inches, in 50° N., 154° W. On the 23d it weakened and moved northward, entering Alaska north of Kodiak.

From the 23d to 29th scattered gales occurred in northern waters, the most important of which, from the standpoint of shipping, swept the upper California coast on the 28th, with a maximum wind force of 10 reported.

Tehuantepecers.—With the appearance over the United States of extensive winter-type anticyclones that carried a far-reaching southward influence, northers were experienced in the Gulf of Tehuantepec, as follows: Of force

7 on the 15th and 25th; of force 8 on the 10th; and of force 9 on the 11th and 16th.

Fog.—Only 1 day with fog was reported over the ocean west of 145° W. Thence eastward to the one hundred and thirtieth meridian, north of the thirty-fifth parallel, it occurred on 1 to 3 days. Fog was observed on 4 days between the mouth of the Columbia River and Puget Sound; on about 16 days off the California coast; and on 4 days off the coast of Lower California.

TYPHOONS IN THE FAR EAST DURING NOVEMBER 1933

C. E. DEPPERMANN, S. J., Assistant Director

[Philippine Weather Bureau, Manila, P.I.]

Before describing the typhoons which traversed the Philippines during November, an additional remark must be made about the last typhoon for October.

(4) *October 26.*—After passing through the islands near the tenth degree of latitude, the typhoon crossed the China Sea in a northwest direction, and on November 1 struck Quinhon in Indo-China with great violence, causing at least 100 deaths in that locality. It is very instructive to note the rapid growth of this typhoon just in crossing the China Sea, a stretch of not more than 600 miles. Nowhere in the Philippines was a barometric pressure recorded less than 745 mm, and the wind forces were comparatively mild, yet Quinhon recorded a well-authenticated minimum of 708 mm with very destructive winds; in fact the storm had developed into the worst Indo-China experienced for at least 11 years.

(1) *November 1.*—To avoid confusion, this typhoon is designated as that of November 1, although really discovered on October 30, southeast of Yap, on the tropical front. It traveled with irregular speed in a northwest direction, until it reached the China Sea; then it recurved and dissipated near Hainan upon meeting the barrier of the Asiatic high pressure area. Like the previous typhoon it moved very quickly during the night when just east of the islands, after remaining almost stationary during the day. Thus it barely gave us time to give proper warning to the more easterly cities affected. It was very fortunate that it had not yet developed fully, for it passed within 20 to 30 miles of 4 important places, Surigao, Cebu, Iloilo, and Culion (famous leper colony). Probably 10 lives were lost all told, and the property damage was comparatively slight. A study may be made later as to the possibility of fronts close to the center of the typhoon, but success will be hampered by the interference with free wind circulation by the topography. Before breaking up, the typhoon must have increased in violence while near Hainan, since Fort Bayard (on south China Coast, north of Hainan), though fully 100 miles away from the center, reported the uprooting of trees.

(2) *November 18.*—This depression, for it was only such and not truly a typhoon, arose near Palau, and after slowly moving north-northwest until latitude 12°, turned westward in passing through the islands, and then dissipated in the China Sea. It was apparently little more than a wave on the tropical front, one of the last feeble attempts of the southwest monsoon as the latter was being pushed back toward the Equator. The air streams could be quite satisfactorily traced in the islands during the passage. No strong winds were experienced.

(3) *November 20.*—Starting below Yap this storm traveled along the tropical front in a northwest direction until it passed through the islands. It then turned westward and dissipated in the middle of the China Sea. This storm well illustrates the danger of coming to conclusions too quickly. During its passage through the islands, not one of our stations reported a barometer less than 752 mm, and winds were weak. There were no indications of a typhoon center, only those of a depression. However, the following day, Baler (some 80 miles northeast of Manila, on east coast) which had not sent observations for a few days due to radio trouble, reported that it had had a minimum of 745 mm, maximum wind force 8! There really had been a true typhoon, but with a very small center. The coastal range of mountains had been sufficient to break this up, for no other station of ours reported similar conditions to Baler.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, November 1933

[For description of table and charts, see REVIEW, January, p. 37]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	55.1	+0.8	Selma	91	3	Scottsboro	18	16	1.14	−2.13	Lock No. 4	3.63	Newton	0.00
Arizona	54.1	+1.3	Parker	97	17	2 stations	7	[1] 16	.96	+.09	Henry's Camp	2.69	2 stations	.00
Arkansas	53.0	+1.5	Conway	85	20	do	20	[1] 8	1.88	−1.75	Malvern	4.91	Crossett	.50
California	53.7	+1.3	Tustin	102	13	Ellery Lake	−4	28	.11	−2.36	Cummings	2.30	114 stations	.00
Colorado	39.1	+4.0	Cheyenne Wells	89	1	Hermit	−9	5	.54	−.26	Cumbres	3.24	4 stations	.00
Florida	63.9	−1.2	4 stations	89	[1] 1	Perry	25	17	1.62	−.60	West Palm Beach	7.22	Mount Pleasant	.00
Georgia	53.8	−.8	6 stations	85	[1] 1	Blairsville	9	16	.96	−1.74	Toccoa	2.85	Newnan	.03
Idaho	37.6	+1.9	Glenns Ferry	76	[1] 25	Obsidian	−1	5	.73	−1.32	Roland	3.80	Glenns Ferry	.00
Illinois	41.5	+.1	Carbondale	88	1	Sycamore	−2	16	.65	−2.02	Charleston	1.53	Lincoln	.02
Indiana	40.8	−1.5	Shoals	91	1	Collegeville	3	16	1.13	−1.93	Howe	2.64	Marion	.27
Iowa	37.9	+1.7	2 stations	83	1	Fayette	−7	16	.31	−1.24	Corning	.78	Marathon	T
Kansas	47.2	+4.0	do	84	1	St. Francis	12	6	.72	−.54	Ulysses	2.40	2 stations	.00
Kentucky	45.5	−1.0	do	85	[1] 1	Farmers	10	17	1.54	−1.94	Quicksand	2.57	Ravenna	.54
Louisiana	60.9	+1.9	do	89	19	2 stations	25	27	1.93	−1.86	Fort Eads	6.41	Robeline	.00
Maryland-Delaware	42.7	−2.4	Hancock, Md	81	1	Oakland, Md	−8	17	1.41	−1.14	Grantsville, Md	3.62	Picardy, Md	.73
Michigan	31.7	−4.7	2 stations	80	1	Deer Park	−17	27	2.11	−.36	Whitefish Point	5.68	Howard City	.60
Minnesota	26.4	−3.3	Farmington	80	1	Big Falls	−27	16	.85	−.31	Mizpah	3.13	Albert Lea	.07
Mississippi	56.3	+1.1	Leakesville	88	4	4 stations	23	[1] 10	1.44	−2.10	2 stations	3.29	3 stations	.48
Missouri	45.9	+1.5	Trenton	83	1	2 stations	7	16	.84	−1.66	Seligman	2.09	2 stations	.06
Montana	37.0	+4.9	Roundup	78	23	Ekalaka	−13	5	.71	−.29	Heron	3.26	Outlook	.07
Nebraska	41.4	+4.7	2 stations	82	1	2 stations	−4	5	.32	−.47	Weeping Water	1.23	Cairo	.00
Nevada	41.8	+2.0	Logandale	86	13	Owyhee	−4	[1] 29	.20	−.44	Caliente	1.36	7 stations	.00
New England	32.5	−5.4	3 stations	71	[1] 2	Van Buren, Maine	−20	29	1.78	−1.66	Whitingham, Vt	3.97	Norwood, Mass	.59
New Jersey	40.6	−3.0	Runyon	78	1	Layton	7	17	1.01	−2.17	Atlantic City	1.89	Belvidere	.08
New Mexico	44.6	+2.0	Hagerman	88	1	Elizabethtown	−4	7	.65	.00	Aspen Grove Ranch	2.32	5 stations	.00
New York	32.6	−5.3	Rochester	80	2	Franklinville	−24	16	2.37	−.64	Jamestown	6.89	Scarsdale	.42
North Carolina	49.0	+.9	2 stations	86	1	Mount Mitchell	0	16	1.07	−1.49	Mount Mitchell	3.85	Belhaven	.00
North Dakota	28.3	+.9	Wahpeton	78	1	Pembina	−15	16	.65	+.04	Jamestown	1.51	Mohall	T
Ohio	38.9	−2.5	2 stations	84	[1] 1	Millersburg	−3	16	1.49	−1.27	Jefferson	3.52	Prospect	.56
Oklahoma	52.5	+2.6	Beaver	86	1	2 stations	20	5	1.60	−.40	Tahlequah	3.66	Lawton	.33
Oregon	41.2	+.6	Powers	77	13	Meacham	−7	29	1.07	−2.67	Headworks	8.58	Yonna	.00
Pennsylvania	38.1	−3.1	Beaver Dam	83	2	Coudersport	−11	16	1.55	−1.31	Corry	5.21	Ephrata	.51
South Carolina	52.1	−1.6	3 stations	85	[1] 1	Caesars Head	13	15	1.23	−1.09	Summerville	4.66	Kershaw	.23
South Dakota	36.3	+3.5	2 stations	78	[1] 1	Redig	−10	5	.24	−.44	2 stations	.80	Geddes	.00
Tennessee	48.9	+.3	Savannah	85	1	Elkmont	9	16	1.95	−1.62	Halls Hill	4.29	New River	.64
Texas	59.7	+2.5	Ballinger	95	29	2 stations	20	[1] 5	1.13	−1.19	Galveston	4.76	5 stations	.00
Utah	39.2	+1.7	Hanksville	82	1	Soldier Summit	−4	6	.56	−.38	Monticello	2.02	Orr's Ranch	T
Virginia	45.2	−1.3	Clarksville	83	1	Mineral	8	17	1.15	−1.21	Walkerton	2.53	Mount Weather	.07
Washington	41.6	+.9	Pomeroy	78	24	Davenport	1	29	3.91	−1.33	Canto	13.29	White Swan	.03
West Virginia	41.4	−1.8	Robertsburg	88	1	Alpena	−5	17	1.98	−.77	Pickens	5.98	Upper Tract	.52
Wisconsin	30.7	−2.6	Fond du Lac	81	1	2 stations	−16	16	.83	−.96	Mellen	2.42	Mauston	.10
Wyoming	35.3	+3.6	Cody	73	13	West Yellowstone	−16	5	.41	−.30	Dome Lake	2.46	Jackson	.00
Alaska (October)	26.4	−4.2	View Cove	63	4	Allakaket	−30	20	2.83	−.55	Yakutat	19.82	Kotzebue	T
Hawaii	70.5	−1.4	Waiawa	93	24	Kanalohuluhulu	38	[1] 29	4.07	−4.41	Puohakamoa No. 2	20.40	2 stations	.00
Puerto Rico	76.6	.0	2 stations	94	[1] 7	Guineo Reservoir	49	7	6.57	−.85	Rio Blanco	17.79	Coamo	.25

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau Stations, November 1933*

[Compiled by Annie E. Small]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							**35.6**	**−3.2**										**73**	**1.66**	**−1.6**										**6.3**		
Eastport	76	67	85	29.81	29.90	−0.11	31.4	−5.3	54	3	39	10	17	24	34	29	25	79	3.32	0.0	15	8,887	nw.	32	s.	22	3	11	16	7.3	14.8	0.0
Greenville, Maine	1,070	6	....	28.69	29.89	....	24.2	....	55	3	33	0	17	16	29	....	....	....	2.17	....	13	5,368	nw.	29	....	30	5	7	18	....	15.8	....
Portland, Maine	103	82	117	29.80	29.92	−.09	35.2	−2.8	66	30	43	10	16	27	31	31	26	72	1.83	−1.6	17	6,712	n.	31	nw.	30	9	10	11	5.3	4.2	0
Concord	289	70	79	....	....	....	33.1	−4.6	67	2	42	7	16	24	37	....	....	....	1.50	....	11	....	nw.	....	....	....	8	11	11	....	5.8	.0
Burlington	403	11	48	29.48	29.94	−.11	27.8	−8.5	59	3	36	1	21	19	46	....	....	....	1.33	−1.3	14	8,849	s.	35	s.	29	2	7	21	8.3	11.8	.0
Northfield	876	12	60	....	29.94	−.11	26.7	−6.1	66	2	37	−5	21	16	40	....	....	82	1.20	−1.7	19	5,847	n.	27	sw.	22	2	7	21	8.2	6.7	T
Boston	125	106	165	29.80	29.94	−.11	38.3	−3.7	70	2	47	12	16	30	34	33	27	67	.65	−2.7	10	10,852	w.	47	w.	30	5	16	9	5.7	2.9	.0
Nantucket	12	14	90	29.92	29.93	−.12	41.4	−3.0	66	3	48	22	16	35	24	38	33	75	2.80	−.4	13	11,044	w.	35	ne.	6	9	9	12	5.8	T	.0
Block Island	26	11	46	29.92	29.95	−.11	41.6	−3.0	64	3	48	19	16	35	26	39	34	76	2.32	−1.3	12	13,304	w.	46	nw.	10	9	10	11	5.7	1.5	.0
Providence	160	215	251	29.77	29.95	−.12	38.8	−1.6	68	30	47	14	16	31	32	34	27	66	1.35	−1.7	10	8,594	nw.	37	nw.	10	12	12	6	4.5	7.4	.0
Hartford	159	70	104	....	29.97	−.11	37.8	−1.7	69	30	46	14	16	30	38	....	....	....	.87	−2.7	7	5,978	s.	....	....	....	13	7	10	....	9.0	.0
New Haven	106	74	153	29.86	29.98	−.09	39.4	−2.6	70	30	47	16	16	32	31	35	29	67	.90	−2.4	10	6,825	n.	29	w.	30	9	10	11	5.6	3.1	.0
Middle Atlantic States							**43.0**	**−1.9**										**69**	**1.07**	**−1.5**										**5.9**		
Albany	97	107	115	29.86	29.97	−.11	35.0	−4.3	67	30	42	9	16	28	37	31	26	71	1.02	−1.8	12	5,929	s.	24	se.	29	5	8	17	6.7	6.7	.0
Binghamton	871	60	68	29.02	29.98	−.11	34.7	−4.0	73	2	42	9	16	27	36	....	....	....	1.18	−1.2	14	4,851	w.	21	nw.	30	2	10	18	7.8	10.1	.0
New York	314	414	454	29.64	29.99	−.10	41.8	−2.4	69	30	49	17	16	34	23	36	30	66	.85	−2.1	7	11,265	w.	53	nw.	10	10	9	11	5.7	.5	.0
Bellefonte	1,050	5	42	28.85	29.98	....	35.4	....	70	1	43	9	16	28	32	32	29	78	.82	....	11	....	sw.	....	....	....	3	9	18	7.6	2.1	.0
Harrisburg	374	94	104	29.60	30.01	−.10	40.0	−2.8	72	1	46	16	17	34	31	35	28	65	.70	−1.6	7	5,796	w.	20	nw	27	8	8	14	6.3	1.2	.0
Philadelphia	114	123	367	29.89	30.02	−.08	44.1	−1.6	73	30	51	20	16	37	27	38	31	63	1.07	−1.6	7	9,518	w.	33	s.	13	9	8	13	5.7	.2	.0
Reading	323	283	304	29.65	30.01	....	43.0	+.5	72	30	51	17	16	35	35	36	29	64	.59	−2.1	8	8,675	nw.	40	nw.	27	5	12	13	6.4	.2	.0
Scranton	805	72	104	29.10	29.98	−.11	36.7	−3.8	69	2	44	11	16	29	28	33	28	75	1.22	−1.6	9	5,499	s.w.	24	nw.	30	4	14	12	6.6	10.7	.0
Atlantic City	52	37	172	29.96	30.02	−.08	44.7	−.9	73	30	52	17	16	38	24	40	35	72	1.89	−.9	9	11,760	w.	41	w.	27	10	8	12	5.9	T	.0
Sandy Hook	22	10	57	29.97	29.99	....	41.8	....	66	30	47	19	16	36	20	38	33	74	1.24	−2.0	8	11,267	w.	47	nw.	27	7	11	12	5.7	.5	.0
Trenton	190	159	183	29.80	30.01	....	41.6	−2.8	71	30	50	16	16	34	32	36	31	71	1.08	−1.6	8	6,924	w.	24	s.	13	9	9	12	5.7	1.0	.0
Baltimore	123	100	215	29.89	30.03	−.08	45.2	−1.1	74	30	52	19	16	38	32	39	32	65	.96	−1.6	8	7,915	sw.	38	sw.	26	11	7	12	5.5	.8	.0
Washington	112	62	83	29.91	30.04	−.08	45.0	−.2	75	30	53	17	17	37	21	38	30	62	.95	−1.4	8	5,438	nw.	27	nw.	27	11	7	12	5.6	.5	.0
Cape Henry	18	8	54	30.02	30.04	....	50.1	−2.0	74	30	57	29	17	43	26	44	38	69	1.22	−1.1	8	9,649	sw.	42	nw.	13	15	6	9	4.6	0	.0
Lynchburg	681	153	188	29.31	30.07	−.06	46.4	−.8	82	1	58	12	17	34	36	....	....	....	1.25	−1.1	9	....	sw.	....	....	....	10	14	6	....	T	.0
Norfolk	91	170	205	29.96	30.07	−.04	50.0	−1.4	74	3	58	26	16	42	28	43	36	66	.99	−1.2	8	9,448	s.	44	nw.	13	15	3	12	4.7	T	.0
Richmond	144	11	52	29.91	30.07	−.05	47.4	−.9	77	3	58	16	17	37	33	40	35	70	1.17	−1.0	6	6,447	sw.	34	nw.	26	10	10	10	5.0	T	.0
Wytheville	2,304	49	55	27.64	30.07	−.06	41.8	−1.2	74	2	51	11	17	33	38	35	30	70	.86	−1.3	10	6,421	w.	29	w.	29	12	6	12	5.4	.4	.0
South Atlantic States							**54.1**	**−0.5**										**69**	**1.04**	**−1.3**										**3.6**		
Asheville	2,253	89	104	27.72	30.12	−.02	45.6	+.5	74	3	57	15	17	34	44	38	32	68	1.19	−1.0	4	8,321	nw	29	nw.	14	16	6	8	4.2	T	.0
Charlotte	779	244	267	29.24	30.09	−.04	51.0	+.4	78	1	60	28	16	42	29	42	33	56	1.03	−1.5	4	8,526	sw.	38	nw.	26	17	6	7	3.6	.0	.0
Greensboro	886	6	56	29.12	30.09	....	46.4	....	78	1	59	15	17	34	44	38	34	73	1.16	....	5	6,022	sw.	33	w.	14	14	7	9	4.2	.0	.0
Hatteras	11	5	50	30.05	30.06	−.05	55.0	−1.3	77	3	61	33	16	49	23	50	47	77	1.84	−1.6	7	9,265	nw.	37	nw.	15	14	6	10	4.6	.0	.0
Raleigh	376	103	146	29.67	30.08	−.05	50.7	−.3	81	1	61	25	17	41	31	42	36	64	1.48	−.8	5	6,534	sw.	32	nw.	13	15	7	8	4.0	.0	.0
Wilmington	72	73	106	30.02	30.10	−.02	54.5	−1.5	79	1	64	29	16	45	28	47	42	74	.38	−1.6	5	6,287	nw.	32	nw.	13	16	8	6	3.3	.0	.0
Charleston	48	11	92	30.05	30.10	−.02	57.0	−1.1	77	1	65	35	16	49	24	50	46	73	2.25	+.1	3	7,203	w.	35	nw.	13	20	2	8	3.3	.0	.0
Columbia, S.C.	351	41	57	29.72	30.11	−.01	53.8	−.2	78	1	65	27	16	42	33	46	39	67	.40	−1.6	5	5,115	sw.	27	sw.	13	19	5	6	3.1	.0	.0
Augusta	182	62	77	29.90	30.10	−.03	54.1	−.4	81	1	66	26	17	42	41	45	39	67	.52	−1.9	5	4,136	nw.	24	w.	13	18	7	5	3.1	.0	.0
Savannah	65	73	152	30.04	30.11	−.01	58.4	−.1	82	3	69	36	16	48	32	50	45	72	.36	−1.7	3	7,504	w.	43	nw.	13	19	6	5	2.8	.0	.0
Jacksonville	43	209	245	30.06	30.11	+.01	61.0	−1.2	78	1	70	38	16	53	26	52	46	67	.95	−1.0	8	7,948	n.	39	s.	13	20	3	7	2.9	.0	.0
Florida Peninsula							**69.5**	**−1.5**										**75**	**0.65**	**−1.6**										**3.6**		
Key West	22	10	64	30.03	30.05	+.03	72.2	−2.1	83	2	77	59	19	68	17	67	64	79	.75	−1.4	3	7,208	ne.	21	nw.	4	17	8	5	3.5	.0	.0
Miami	25	124	168	30.03	30.06	.00	70.7	−1.1	83	4	77	54	27	64	22	63	60	74	.90	−2.0	6	7,553	n.	24	n.	4	11	12	7	4.9	.0	.0
Tampa	35	79	197	30.06	30.10	+.02	65.6	−1.3	84	5	75	46	17	56	30	57	52	73	.30	−1.4	3	8,273	ne.	25	ne.	25	22	4	4	2.3	.0	.0
Titusville	44	5	....	30.04	30.09	....	63.7	....	82	22	74	44	18	54	32	....	....	....	4.42	....	5	....	nw.	....	....	....	21	3	6	....	.0	.0
East Gulf States							**57.1**	**+1.0**										**68**	**1.39**	**−1.9**										**3.4**		
Atlanta	1,173	190	216	28.87	30.13	.00	51.6	−.5	76	1	61	26	16	42	28	45	39	67	.80	−2.2	5	8,203	w.	35	nw.	26	18	5	7	3.4	.0	.0
Macon	370	78	87	29.73	30.13	.00	53.6	−.6	79	3	66	25	17	41	39	45	37	65	1.06	−1.5	3	4,891	nw.	22	nw.	26	19	2	9	3.0	.0	.0
Thomasville	273	49	103	29.87	30.14	+.02	59.6	+1.1	82	1	72	34	16	48	37	50	43	67	.25	....	2	....	e.	....	....	....	17	10	3	....	.0	.0
Apalachicola	36	11	51	30.08	30.12	....	60.8	....	80	4	70	40	14	52	28	54	....	....	.33	−2.7	4	....	n.	....	....	....	21	8	1	....	.0	.0
Pensacola	56	149	185	30.08	30.14	+.03	60.6	+.4	79	3	68	42	14	53	27	54	48	69	1.62	−2.1	3	8,229	ne.	30	s.	21	19	8	3	2.8	.0	.0
Anniston	741	9	57	....	....	....	53.2	+1.3	80	1	65	22	16	41	39	....	....	....	2.41	....	5	....	nw.	....	....	....	14	7	9	....	.0	.0
Birmingham	700	11	48	29.37	30.15	+.03	54.6	+.7	80	3	65	28	16	44	34	46	40	66	2.57	−.7	3	5,026	nw.	21	nw.	26	19	4	7	3.5	.0	.0
Mobile	57	125	161	30.08	30.14	+.03	60.0	+1.4	81	3	69	39	11	51	32	52	47	71	.66	−3.0	4	6,502	n.	23	nw.	26	19	7	4	2.9	.0	.0
Montgomery	223	100	112	29.90	30.16	+.04	56.5	+.7	81	3	67	33	9	46	35	47	40	61	.36	−2.9	5	4,741	nw.	21	nw.	13	19	3	8	3.3	.0	.0
Meridian	378	87	95	29.75	30.16	+.04	56.5	+2.3	81	4	68	32	16	45	38	48	43	71	1.66	−1.7	6	3,944	n.	18	nw.	26	18	6	6	3.4	.0	.0
Vicksburg	247	65	73	29.89	30.16	+.04	58.3	+1.7	79	20	68	38	8	49	32	50	44	67	1.24	−2.5	7	5,095	n.	21	nw.	13	15	4	11	4.4	.0	.0
New Orleans	53	76	84	30.09	30.15	+.05	64.1	+2.5	83	4	71	48	16	57	26	56	51	72	3.60	+.5	10	4,844	ne.	18	e.	1	15	11	4	3.7	.0	.0
West Gulf States							**61.1**	**+3.4**										**71**	**1.46**	**−1.4**										**4.1**		
Shreveport	249	77	93	29.88	30.16	+.05	59.8	+3.8	82	21	70	38	25	50	33	52	46	69	.79	−2.9	4	7,735	s.	31	sw.	28	15	11	4	3.4	.0	.0
Bentonville	1,303	11	44	28.72	30.10	−.01	49.8	+3.1	79	1	60	28	10	40	35	....	....	....	2.71	....	5	5,077	sw.	21	sw.	28	11	10	9	....	.0	.0
Fort Smith	457	79	94	29.64	30.12	+.01	54.2	+3.2	78	1	65	32	10	44	37	45	39	65	1.62	−1.2	3	5,684	e.	28	sw.	17	15	9	6	4.4	.0	.0
Little Rock	357	136	153	29.76	30.15	+.03	53.6	+1.5	77	20	63	32	8	44	37	46	39	64	1.68	−2.5	3	5,901	sw.	22	sw.	27	13	9	8	4.7	.0	.0
Austin	605	136	148	29.50	30.13	....	62.4	+3.9	84	18	74	35	25	51	40	54	48	68	.68	−1.6	5	5,753	s.	27	n.	24	12	10	8	4.5	.0	.0
Brownsville	57	83	100	30.02	30.08	....	69.7	+2.5	86	1	77	49	25	63	24	64	62	84	2.42	+.4	10	6,848	se.	26	nw.	3	15	6	9	4.5	.0	.0
Corpus Christi	20	11	78	30.11	30.13	+.06	67.4	+3.1	87	21	74	51	25	61	25	62	59	81	1.33	−.7	5	6,845	s.	30	s.	28	14	9	7	4.4	.0	.0
Dallas	512	220	227	29.58	30.13	....	58.4	....	80	14	68	37	8	49	33	50	42	61	.79	−1.8	4	8,528	s.	37	nw.	24	17	5	8	3.9	.0	.0
Fort Worth	670	106	114	29.43	30.15	+.05	59.0	+3.5	84	14	70	36	8	48	36	....	....	....	.66	−1.9	2	5,941	sw.	27	sw.	20	17	3	10	4.0	.0	.0
Galveston	54	106	114	30.08	30.14	+.05	66.4	+3.1	78	21	71	50	25	61	23	61	58	81	4.76	+1.4	6	7,294	s.	26	n.	24	17	7	6	3.2	.0	.0
Houston	138	292	314	29.99	30.15	....	64.8	+3.8	82	21	73	45	25	57	25	....	....	....	2.03	−1.8	6	8,745	n.	30	se.	28	14	12	4	3.7	.0	.0
Palestine	510	64	72	29.62	30.16	+.05	61.0	+3.8	81	28	71	39	25	51	34	52	46	66	.90	−2.5	3	5,476	s.	25	nw.	24	13	12	5	3.9	.0	.0
Port Arthur	34	58	66	30.10	30.14	....	64.2	....	82	19	72	44	25	56	30	57	54	80	.65	−2.4	4	6,019	e.	26	n.	24	15	12	3	4.0	.0	.0
San Antonio	693	242	301	29.39	30.11	+.03	65.3	+5.0	84	15	75	46	25	55	31	55	48	64	.65	−1.2	5	8,059	e.	29	s.	28	11	10	9	4.6	.0	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, November 1933*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							44.7	**−0.8**										**68**	**1.37**	**−1.8**										**5.9**		
Chattanooga	762	190	215	29.32	30.14	0.00	51.0	+0.6	77	1	61	26	16	41	33	43	36	62	1.44	−1.9	3	5,680	sw.	30	nw.	14	17	5	8	3.7	0.0	0.0
Knoxville	995	102	111	29.07	30.12	−.01	49.4	+1.5	78	2	59	23	17	40	31	41	34	63	1.17	−1.9	7	5,195	sw.	27	w.	14	15	7	8	3.9	.0	.0
Memphis	399	76	97	29.70	30.13	+.01	53.1	+1.4	79	1	62	31	16	44	27	46	39	65	1.17	−3.1	2	6,185	sw.	30	nw.	13	14	10	6	4.4	.0	.0
Nashville	546	168	191	29.54	30.14	+.02	49.6	+.6	78	1	60	24	16	40	34	43	36	65	1.47	−2.0	6	6,886	nw.	33	nw.	14	14	7	9	4.8	.0	.0
Lexington	989	193	230	------	------	------	42.0	−2.8	77	2	52	17	16	32	40	------	------	------	1.55	------	9	------	ne.	------	------	------	8	8	14	------	.2	.0
Louisville	525	188	234	29.51	30.10	−.02	45.0	−1.7	79	1	54	18	15	36	32	39	32	64	1.30	−2.3	7	8,568	s.	41	nw.	14	9	6	15	6.2	T	.0
Evansville	431	76	116	29.62	30.10	−.02	46.0	−.6	81	1	55	21	15	37	30	39	33	65	.72	−3.0	4	7,439	sw.	29	nw.	14	14	3	13	5.3	T	.0
Indianapolis	822	194	230	29.16	30.07	−.03	40.7	−1.6	78	1	50	12	15	32	31	35	30	68	1.16	−2.2	10	8,988	w.	32	nw.	14	6	7	17	6.8	.1	.0
Terre Haute	575	96	129	29.44	30.07	------	42.0	------	80	1	52	16	15	32	33	36	31	69	.63	−2.7	8	7,869	s.	30	nw.	14	9	10	11	5.4	T	.0
Cincinnati	627	11	51	29.38	30.08	−.04	42.4	−.1	79	1	52	15	15	33	32	36	31	71	1.28	−1.6	10	6,887	sw.	26	nw.	26	6	8	16	6.5	1.5	.0
Columbus	822	216	230	29.15	30.04	−.07	40.6	−1.3	78	1	49	13	16	32	31	36	31	72	1.02	−1.8	10	9,621	sw.	40	w.	9	6	7	17	6.8	2.7	.0
Elkins	1,947	59	67	27.98	30.09	−.03	39.2	−1.1	75	2	49	−2	17	29	53	34	30	76	3.17	+.4	18	5,826	w.	28	nw.	14	3	6	21	8.0	9.6	.0
Parkersburg	637	77	82	29.42	30.09	−.03	42.7	−1.1	82	2	52	11	16	33	38	37	32	73	1.56	−1.0	12	5,575	sw.	28	nw.	14	6	8	16	7.1	6.0	.0
Pittsburgh	842	353	410	29.11	30.03	−.07	39.6	−3.6	78	2	47	9	16	32	28	35	30	71	1.68	−.6	14	7,532	w.	32	w.	26	4	8	18	7.3	5.2	.0
Lower Lake Region							**35.1**	**−4.2**										**76**	**2.39**	**−0.4**										**7.9**		
Buffalo	767	243	280	29.09	29.94	−.11	34.2	−5.2	72	2	41	8	15	27	31	31	28	81	2.68	−.3	19	12,831	w.	49	sw.	30	4	8	18	7.5	17.9	.0
Canton	448	10	61	29.42	29.92	------	25.8	−8.1	68	2	36	−2	16	15	50	------	------	------	2.64	−.5	19	6,357	sw.	30	sw.	21	2	8	20	7.9	16.2	.0
Ithaca	836	74	100	29.03	29.96	------	34.2	−4.4	73	2	42	8	16	27	31	31	26	74	1.27	−1.1	17	7,864	nw.	31	s.	13	2	7	21	8.2	11.5	.0
Oswego	335	71	85	29.56	29.94	−.11	33.0	−5.9	68	2	40	5	16	26	34	31	28	84	4.55	+1.2	21	8,794	s.	27	nw.	11	1	4	25	8.6	28.9	.0
Rochester	523	86	102	29.37	29.96	−.09	34.6	−4.1	80	2	42	8	16	27	29	31	26	73	3.01	+.5	19	5,992	w.	32	w.	30	1	8	21	8.3	19.3	.0
Syracuse	596	65	79	29.31	29.97	−.09	34.3	−4.4	75	2	42	6	16	26	38	------	------	------	3.01	+.2	20	6,326	w.	25	nw.	30	4	4	22	8.0	19.6	.0
Erie	714	130	166	29.18	29.96	−.10	37.6	−3.8	76	2	44	14	16	31	28	34	30	77	2.55	−.8	18	11,773	sw.	40	s.	12	4	7	19	8.1	11.2	.0
Cleveland	762	267	337	29.14	29.98	−.09	39.0	−1.9	75	1	46	12	16	32	30	34	29	72	3.06	+.4	19	12,242	sw.	51	w.	14	6	1	23	8.1	15.2	.0
Sandusky	629	5	67	29.30	30.00	−.08	38.0	−3.1	78	2	46	5	16	30	30	------	------	------	1.90	−.5	14	8,427	sw.	30	nw.	14	5	4	21	7.7	8.1	.0
Toledo	628	208	243	29.31	30.01	−.06	37.1	−3.3	77	1	44	9	16	30	30	33	29	75	1.16	−1.2	13	7,940	w.	27	nw.	13	5	4	21	7.4	4.1	.0
Fort Wayne	856	100	119	29.08	30.02	------	37.6	−3.0	77	1	45	10	15	30	28	34	30	76	1.17	−1.7	15	8,221	w.	30	sw.	12	5	7	18	7.1	6.8	.0
Detroit	730	218	258	29.18	29.99	−.07	36.0	−3.3	75	2	43	8	16	29	26	32	28	76	1.68	−.8	13	8,494	sw.	32	sw.	29	4	6	20	7.9	10.5	.0
Upper Lake Region							**31.0**	**−4.3**										**80**	**1.83**	**−0.5**										**8.1**		
Alpena	609	13	89	29.26	29.94	−.07	29.6	−4.8	76	2	37	−1	15	22	41	27	23	79	1.59	−1.0	17	8,558	nw.	31	nw.	13	1	10	19	8.2	13.7	T
Escanaba	612	54	60	29.28	29.96	−.07	28.5	−4.6	57	1	34	3	16	22	24	27	23	80	1.30	−.8	17	8,030	nw.	35	n.	26	3	5	22	8.1	11.5	1.0
Grand Rapids	707	70	244	29.20	29.98	−.07	35.0	−3.4	72	2	41	10	15	29	31	32	28	78	2.83	+.1	15	8,887	nw.	35	sw.	29	3	4	23	8.3	11.2	.0
Lansing	878	6	88	29.01	29.97	------	33.1	−4.4	74	2	40	5	16	26	30	32	30	90	2.56	+.1	15	7,859	w.	27	nw.	13	4	1	25	8.5	9.9	.0
Ludington	637	60	66	29.25	29.96	------	34.0	−3.4	68	1	38	12	15	30	19	31	------	------	1.90	−.8	17	------	nw.	------	------	------	1	5	24	------	15.9	.0
Marquette	734	77	111	29.12	29.94	−.08	28.2	−5.1	63	1	34	7	16	22	31	26	24	84	2.79	−.1	20	8,225	w.	35	sw.	16	1	2	27	9.2	25.0	4.2
Sault Ste. Marie	614	11	52	29.23	29.96	−.05	24.1	−7.9	52	2	31	−2	15	17	36	23	20	85	3.83	+1.2	23	6,813	se.	36	nw.	30	0	5	25	8.8	39.5	12.7
Chicago	673	7	131	29.28	30.02	−.05	38.0	−2.1	77	1	45	9	16	31	33	34	29	70	.68	−1.7	9	8,986	nw.	32	nw.	12	5	7	18	7.0	1.4	.0
Green Bay	617	109	141	29.29	29.97	−.07	31.6	−3.0	74	1	38	1	16	24	31	28	23	73	.70	−1.5	9	8,384	w.	35	nw.	13	3	5	22	7.8	7.7	.0
Milwaukee	681	125	221	29.24	30.00	−.05	35.4	−1.9	71	1	42	5	16	28	28	31	26	72	1.03	−.7	12	10,488	nw.	38	n.	26	4	8	18	7.0	3.5	.0
Duluth	1,133	5	47	28.72	29.98	−.06	23.6	−6.4	50	1	30	−10	16	17	33	22	20	88	.88	−.6	14	9,262	nw.	46	nw.	13	3	6	21	8.0	13.7	1.3
North Dakota							**28.3**	**+1.5**										**82**	**0.76**	**+0.1**										**6.5**		
Moorhead, Minn	940	50	58	29.00	30.05	−.02	25.4	−1.7	66	1	34	−2	16	16	41	23	20	85	.91	.0	9	7,320	nw.	35	n.	12	5	8	17	7.1	11.2	T
Bismarck	1,674	8	57	28.23	30.07	.00	31.4	+2.9	61	24	40	8	9	22	34	28	24	79	.74	+.2	6	7,597	nw.	50	nw.	12	8	8	14	6.3	7.8	.0
Devils Lake	1,478	11	44	28.42	30.05	−.01	24.4	−.1	54	20	33	2	9	16	35	23	21	88	.73	.0	10	8,071	nw.	40	nw.	12	5	8	17	7.4	5.4	.2
Grand Forks	833	12	67	------	------	------	22.8	------	56	1	32	−5	15	14	44	21	------	------	1.15	------	15	------	nw.	48	nw.	14	0	14	16	------	16.8	1.1
Williston	1,878	41	48	28.06	30.09	+.03	32.0	+4.8	57	24	40	3	7	24	29	28	24	78	.66	+.1	8	6,946	w.	46	nw.	12	11	9	10	5.2	6.2	T
Upper Mississippi Valley							**38.7**	**+0.1**										**69**	**0.51**	**−1.5**										**6.0**		
Minneapolis	918	102	208	29.00	30.01	------	30.7	−1.7	77	1	39	−2	16	22	38	27	23	75	.57	−.7	10	8,801	nw.	41	w.	12	7	5	18	7.2	5.7	.0
La Crosse	714	11	48	29.22	30.01	−.06	33.9	−1.3	80	1	42	3	16	26	37	29	25	76	.36	−1.2	8	4,921	nw.	22	nw.	14	6	4	20	7.3	.7	.0
Madison	974	70	78	28.93	30.02	−.04	34.0	−1.2	77	1	42	3	16	26	32	30	26	75	.44	−1.3	8	7,832	nw.	30	w.	12	7	6	17	6.6	2.6	.0
Charles City	1,015	10	51	28.95	30.06	−.02	33.1	+.1	78	1	43	2	16	23	38	28	24	75	.23	−1.3	3	5,938	nw.	27	nw.	12	8	6	16	6.1	1.4	.0
Davenport	606	118	143	29.38	30.06	−.02	38.8	−.2	79	1	48	7	16	29	39	33	28	69	.28	−1.5	5	9,163	nw.	43	nw.	12	7	11	12	6.1	.5	.0
Des Moines	861	5	99	29.14	30.07	−.01	39.8	+1.4	78	1	51	11	16	29	42	34	27	66	.22	−1.2	3	7,896	nw.	41	w.	12	9	7	14	5.7	.1	.0
Dubuque	700	81	96	29.26	30.04	−.03	36.4	−.6	78	1	45	6	16	28	36	31	25	69	.28	−1.4	6	5,997	nw.	28	n.	14	8	7	15	6.4	2.7	.0
Keokuk	614	64	78	29.40	30.09	.00	41.8	+.7	80	1	53	10	16	31	36	35	27	60	.33	−1.6	1	6,913	nw.	36	nw.	12	11	9	10	5.3	T	.0
Cairo	358	87	93	29.72	30.11	−.01	48.4	+1.1	78	1	58	25	15	39	31	42	35	65	1.23	−2.4	7	7,069	nw.	27	nw.	13	12	7	11	5.2	.0	.0
Peoria	609	11	45	29.39	30.07	−.02	39.6	+2.1	80	1	49	11	16	30	37	34	29	70	.26	−2.1	4	6,215	nw.	28	w.	12	11	9	10	5.0	T	.0
Springfield, Ill	636	5	191	29.38	30.07	−.03	42.1	−.1	80	1	52	17	15	33	36	37	32	72	.28	−2.2	4	9,390	nw.	38	nw.	14	8	10	12	5.6	T	.0
St. Louis	568	265	303	29.46	30.08	−.02	46.0	+.9	79	1	55	20	16	37	33	39	32	61	1.64	−1.2	6	9,458	nw.	38	sw.	17	13	8	9	4.9	.0	.0
Missouri Valley							**43.4**	**+3.6**										**62**	**0.54**	**−0.9**										**4.4**		
Columbia, Mo	784	6	84	29.25	30.10	+.01	44.8	+1.5	78	1	55	18	16	34	38	------	------	------	.80	−1.4	5	7,226	sw.	34	nw.	12	17	5	8	3.8	T	.0
Kansas City	963	10	86	29.06	30.12	+.03	47.2	+3.5	80	1	56	22	16	38	33	39	30	56	.31	−1.5	4	8,535	sw.	41	w.	12	15	6	9	4.5	T	.0
St. Joseph	967	11	49	29.04	30.10	------	45.1	------	80	1	56	20	16	34	36	37	29	59	.52	−1.1	4	7,323	nw.	41	nw.	12	16	7	7	3.8	T	.0
Springfield, Mo	1,324	98	104	28.69	30.12	+.02	48.2	+2.5	75	1	57	28	10	39	30	41	35	68	1.01	−1.8	7	7,653	s.	34	nw.	25	16	5	9	3.8	T	.0
Iola	984	11	50	29.06	30.12	+.03	49.6	+5.5	78	1	62	27	10	38	39	------	------	------	1.16	−.7	6	------	n.	------	------	------	16	6	8	------	.0	.0
Topeka	987	92	107	------	------	------	46.6	+3.8	80	1	58	24	16	36	38	------	------	------	.58	−.9	3	7,343	nw.	36	nw.	12	18	6	6	3.4	.0	.0
Lincoln	1,189	11	81	28.80	30.10	+.02	43.0	+3.9	80	1	55	19	16	31	42	36	28	61	.60	−.5	5	7,888	nw.	46	nw.	25	14	11	5	4.1	T	.0
Omaha	1,105	115	122	28.89	30.10	+.02	42.0	+3.5	78	1	53	18	16	31	41	35	27	59	.37	−.7	4	6,960	nw.	37	nw.	12	13	11	6	4.3	1.1	.0
Valentine	2,598	47	54	27.36	30.14	+.06	39.0	+4.4	71	19	52	8	6	26	47	31	24	61	.24	−.3	4	7,481	w.	37	nw.	12	12	8	10	5.0	1.7	.0
Sioux City	1,135	94	164	28.84	30.08	.00	38.4	+3.2	74	20	50	12	16	27	46	32	24	63	.09	−.9	3	8,785	nw.	46	nw.	12	10	9	11	5.3	T	.0
Huron	1,306	59	74	28.66	30.09	+.01	35.2	+3.7	65	1	47	8	16	23	44	29	23	65	.22	−.4	5	7,377	w.	45	w.	12	9	9	12	5.9	2.6	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, November 1933*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F.*	°*F.*		°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Northern Slope							**38.4**	**+5.6**										**65**	**0.51**	**−0.2**										**5.3**		
Billings	3,140	5																														
Havre	2,505	11	67	27.44	30.13	+0.10	36.4	+5.2	69	13	46	2	5	27	36	32	27	70	0.53	−.1	6	8,342	sw.	36	nw.	21	4	14	12	6.4	4.5	T
Helena	4,124	89	113	25.94	30.21	+.11	39.6	+6.4	67	13	49	8	4	31	38	34	27	63	.73	.0	6	6,142	sw.	39	sw.	24	4	13	13	6.6	9.7	3.2
Kalispell	2,973	48	56	27.12	30.25	+.18	37.2	+4.8	62	26	45	19	4	30	30	34	32	84	1.31	.0	6	3,576	nw.	30	sw.	26	5	6	19	7.1	.6	.0
Miles City	2,371	48	55	27.57	30.18	+.11	38.2	+7.3	70	13	49	−1	5	27	39	32	27	71	.41	−.2	6	5,003	s.	36	nw.	20	9	15	6	5.1	2.8	.0
Rapid City	3,259	50	58	26.68	30.16	+.08	40.9	+5.0	72	19	54	5	5	28	41	33	24	56	.12	−.4	3	6,940	nw.	41	nw.	12	13	10	7	4.4	1.0	.0
Cheyenne	6,088	84	101	24.09	30.14	+.07	40.2	+5.4	66	19	53	7	5	28	42	31	20	49	.27	−.2	4	10,121	w.	46	w.	12	13	12	5	4.7	2.7	.0
Lander	5,372	60	68	24.76	30.23	+.13	37.0	+6.7	67	13	52	0	5	22	41	29	22	64	.86	+.3	3	3,449	s.	28	n.	20	18	7	5	3.5	13.2	.0
Sheridan	3,790	10	47	26.19	30.18		38.5		72	13	53	−1	5	24	46	30	24	68	.39	−.2	6	4,331	nw.	35	nw.	20	10	10	10	5.0	.8	.0
Yellowstone Park	6,241	11	48	24.04	30.31	+.20	33.4	+4.1	55	19	43	1	5	24	35	28	21	65	.32	−1.0	3	5,969	sw.	26	sw.	26	7	9	14	6.3	4.6	.0
North Platte	2,821	11	51	27.15	30.14	+.06	42.0	+5.4	72	19	56	14	6	28	43	32	24	59	.17	−.3	3	6,040	w.	32	nw.	23	19	7	4	3.5	1.4	.0
Middle Slope							**47.8**	**+5.0**										**53**	**0.71**	**−0.3**										**3.2**		
Denver	5,292	106	113	24.82	30.13	+0.07	46.2	+6.4	74	13	59	13	5	33	41	34	20	43	.18	−.4	3	6,046	s.	30	n.	25	19	9	2	3.2	2.5	0.0
Pueblo	4,685	80	86	25.39	30.14	+.09	45.0	+5.6	75	27	62	10	6	28	48	34	20	42	.12	−.2	2	4,921	n.	28	w.	25	17	11	2	3.0	1.2	.0
Concordia	1,392	50	58	28.64	30.15	+.07	46.3	+4.9	80	1	58	23	16	34	40	37	28	57	.84	−.2	5	6,716	w.	37	nw.	25	18	8	4	3.0	.2	.0
Dodge City	2,509	10	86	27.51	30.16	+.09	47.0	+4.4	81	27	60	23	6	34	43	37	29	61	.38	−.4	6	8,313	w.	32	n.	1	24	2	4	2.3	.3	.0
Wichita	1,358	85	93	28.66	30.12	+.04	49.5	+4.7	78	1	60	28	6	39	32	41	32	59	.85	−.5	4	7,775	sw.	29	s.	28	18	5	7	3.5	T	.0
Oklahoma City	1,214	10	47	28.84	30.14	+.06	52.8	+4.0	79	1	63	32	8	42	35	44	37	66	1.88	.0	4	7,121	s.	27	n.	23	14	8	8	4.3	.0	.0
Southern Slope							**55.6**	**+3.8**										**62**	**1.18**	**+0.1**										**3.3**		
Abilene	1,738	10	52	28.31	30.14	+.07	57.6	+4.1	82	1	70	35	8	46	39	48	41	65	2.70	+1.4	5	6,562	s.	30	sw.	17	19	6	5	3.1	.0	.0
Amarillo	3,676	10	49	26.37	30.14	+.09	50.4	+4.9	78	14	63	24	5	38	40	39	30	56	.58	−.3	4	6,591	sw.	22	n.	25	19	7	4	3.3	T	.0
Big Spring	2,537	5	62	27.49	30.14		55.6		81	14	69	35	6	43	44	45	39	66	.87		7		s.				20	4	6	3.3	.0	.0
Del Rio	944	64	71	29.09	30.09	+.04	63.4	+3.4	81	12	74	42	4	53	36	55	47	65	.33	−.9	4	5,782	se.	26	n.	2	13	12	5	4.3	.0	.0
Roswell	3,566	75	85	26.49	30.14	+.11	50.8	+2.7	80	25	67	28	8	35	50	40	31	58	1.13	+.3	4	4,776	n.	29	sw.	28	22	6	2	2.4	T	.0
Southern Plateau							**52.4**	**+3.2**										**48**	**0.35**	**−0.2**										**2.1**		
El Paso	3,778	152	175	26.30	30.11	+.11	55.4	+2.7	78	17	69	35	3	42	36	42	30	42	.04	−.5	4	5,134	nw.	38	w.	1	22	6	2	1.9	.0	.0
Albuquerque	4,972	51	66	25.17	30.16		44.1		69	25	60	24	20	29	43	34	28	63	.91		6	4,699	n.	29	s.	4	19	6	5	2.9	.2	.0
Santa Fe	7,013	38	53	23.35	30.17	+.14	41.7	+2.8	67	14	53	20	6	30	32	32	22	53	1.02	+.3	6	4,563	se.	21	se.	4	17	11	2	2.9	3.0	.0
Flagstaff	6,907	10	59	23.45	30.13	+.11	38.6	+4.0	68	24	56	7	30	21	49	28		59	.78		2	5,832	n.	37	ne.	2	22	7	1		6.0	5.0
Phoenix	1,108	10	107	28.88	30.04	+.06	62.7	+3.0	87	14	79	38	7	46	42	47	32	39	.62	−.1	1	3,601	e.	21	nw.	1	24	5	1	1.7	.0	.0
Yuma	141	9	54	29.89	30.04	+.06	65.2	+2.8	89	14	80	39	30	51	39	48	31	33	.02	−.3	1	4,450	n.	22	w.	28	24	5	1	1.3	.0	.0
Independence	3,957	6	27	26.14	30.22	+.17	51.0	+3.8	73	13	67	28	7	35	39	35			.03	−.3	1		n.				25	0	5			
Middle Plateau							**41.2**	**+2.0**										**55**	**0.37**	**−0.4**										**2.4**		
Reno	4,532	74	81	25.67	30.29	+.18	43.8	+2.8	68	15	60	18	30	28	40	34	26	56	.04	−.6	1	3,584	sw.	41	w.	27	26	3	1	1.5	.6	T
Tonopah	6,090	12	20				44.6		64	24	54	18	29	36	25	33	17	35	.02		1		w.									
Winnemucca	4,344	18	56	25.84	30.33	+.19	39.2	+.8	68	13	57	10	30	22	44	30	22	60	.09	−.6	1	4,801	ne.	28	nw.	27	24	3	3	2.2	1.2	T
Modena	5,473	10	43	24.77	30.20	+.12	38.6	+2.2	66	15	55	11	6	22	43	29	19	55	.87	+.3	4	5,984	w.	38	sw.	28	23	3	4	2.4	5.8	2.6
Salt Lake City	4,360	163	203	25.83	30.28	+.16	43.2	+2.1	62	24	53	25	6	33	27	36	29	60	.19	−1.2	5	4,052	se.	30	nw.	3	19	7	4	3.1	.2	.0
Grand Junction	4,602	60	68	25.55	30.20	+.12	41.4	+2.1	65	25	55	22	21	28	38	34	26	62	.66	+.1	5	3,582	se.	23	s.	28	20	6	4	2.8	1.8	.0
Northern Plateau							**41.0**	**+2.0**										**76**	**0.54**	**−0.8**										**5.9**		
Baker	3,471	48	53	26.69	30.36	+.20	38.2	+2.2	59	12	49	14	29	27	34	34	31	79	.41	−.6	6	4,831	se.	18	n.	3	16	8	6	4.1	1.5	.2
Boise	2,739	79	87	27.43	30.35	+.18	42.4	+1.4	62	2	53	21	29	32	28	37	31	67	.24	−1.0	3	3,130	nw.	22	nw.	3	12	13	5	4.2	T	.0
Pocatello	4,477	60	68	25.68	30.29	+.15	40.2	+3.5	62	26	51	15	5	29	32	33	27	65	.47	−.4	3	5,523	se.	23	sw.	28	15	7	8	4.4	1.9	.0
Spokane	1,929	101	110	28.20	30.31	+.21	39.1	+.6	60	23	45	19	30	33	23	37	35	86	.80	−1.3	7	3,588	s.	22	sw.	2	4	5	21	8.1	2.5	1.0
Walla Walla	991	57	65	29.22	30.31	+.18	43.8	+1.0	69	23	50	30	6	38	27	41	37	80	1.08	−.9	8	3,114	s.	18	w.	24	5	6	19	7.6	T	.0
Yakima	1,076	58	67	29.14	30.31		42.0	+3.1	72	22	51	21	29	33	34	38	34	77	.21	−.6	5	2,903	nw.	21	sw.	2	6	3	21	7.1	.0	.0
North Pacific Coast Region							**47.0**	**+0.6**										**88**	**3.48**	**−3.0**										**7.4**		
North Head	211	11	56	30.03	30.27	+.22	48.7	+.5	64	23	53	38	28	44	19	47	45	91	4.50	−4.0	12	7,690	n.	43	s.	2	8	2	20	6.9	.0	.0
Seattle	125	215	250	30.13	30.27	+.23	46.8	+1.2	60	24	51	36	29	43	16	46	44	88	3.41	−1.6	14	5,289	s.	35	s.	22	1	3	26	9.1	.0	.0
Tatoosh Island	86	9	53	30.14	30.24	+.27	47.6	+1.7	54	21	50	39	28	45	10	47	46	94	9.35	−2.6	16	10,131	e.	49	s.	20	6	4	20	7.5	.0	.0
Medford	1,329	29	58	28.84	30.28		42.0		65	5	55	18	29	29	39	35	78	.03	−2.4	2	2,553	s.	16	nw.	28	9	12	9	5.5	T	.0
Portland, Oreg	153	68	106	30.12	30.28	+.18	46.5	−.3	62	2	52	35	29	41	17	44	42	87	2.54	−3.6	11	3,881	nw.	19	s.	1	4	7	19	7.7	.0	.0
Roseburg	510	75	99	29.73	30.29	+.17	45.6	−.3	65	21	53	30	29	38	23	44	42	87	1.02	−3.6	7	2,345	n.	15	w.	27	1	10	19	7.9	T	.0
Middle Pacific Coast Region							**55.8**	**+2.0**										**67**	**0.10**	**−3.0**										**2.8**		
Eureka	62	73	89	30.16	30.23	+.12	49.8	−1.3	76	13	56	35	29	43	28	47	46	88	.38	−4.8	4	3,443	n.	26	n.	28	12	5	13	5.4	.0	.0
Red Bluff	330	5	58	29.80	30.17	+.06	56.8	+3.0	81	13	71	34	30	43	37	47	37	56	.00	−3.0	0	4,087	nw.	22	w.	27	20	6	4	2.4	.0	.0
Sacramento	69	106	117	30.07	30.14	+.05	56.4	+2.8	77	13	70	38	30	43	32	48	41	60	.00	−1.9	0	4,352	n.	28	nw.	28	28	1	1	.7	.0	.0
San Francisco	155	208	243	29.97	30.13	+.04	60.0	+3.7	80	13	68	46	30	52	22	51	44	63	.00	−2.4	0	3,956	n.	30	n.	28	18	9	3	2.8	.0	.0
South Pacific Coast Region							**61.8**	**+3.5**										**53**	**0.02**	**−0.9**										**2.3**		
Fresno	327	89	98	29.78	30.14	+.08	57.5	+3.3	79	14	71	37	29	44	34	48	39	54	.00	−.9	0	2,925	nw.	21	nw.	28	24	4	2	1.7	.0	.0
Los Angeles	338	159	191	29.71	30.07	+.05	66.5	+5.6	96	13	78	41	29	55	33	50	35	42	.04	−1.2	1	4,180	ne.	21	nw.	28	24	5	1	1.7	.0	.0
San Diego	87	62	70	29.96	30.05	+.03	61.4	+1.7	87	13	71	43	29	52	26	52	44	62	.03	−.7	2	3,907	nw.	27	w.	28	15	10	5	3.4	.0	.0
West Indies																																
San Juan, P.R.	82	9	54	29.82	29.90		79.0	+.6	88	3	84	72	18	74	15				5.68	−1.1	25	8,186	e.	31	ne.	18	3	24	3	5.7	.0	.0
Panama Canal																																
Balboa Heights	118	6	97		[1] 29.83	+.02	77.8	−1.3	88	21	84	70	9	72	16			[1] 89	13.28	+3.0	24	3,818	nw.	23	w.	26	0	9	21	8.3	.0	.0
Cristobal	36	6	97		[1] 29.84	+.02	78.8	−.5	89	2	84	70	27	74	14	75	74	[1] 86	43.06	+21.2	28	5,590	w.	39	w.	26	0	7	23	8.5	.0	.0
Alaska																																
Fairbanks	455	11	44	[2] 29.30	[2] 29.85		7.5		41	3	14	−36	30	1	28	8	4	76	.73		14	2,436	n.	12	s.	12	3	4	23	8.1	12.4	19.0
Juneau	80	11	50	[2] 29.80	[2] 29.89		39.4		53	14	44	28	27	35	17	38	36	87	13.23		26	5,213	s.	25	e.	12	1	3	26	9.2	6.3	T
Hawaiian Islands																																
Honolulu	38	86	100	[2] 29.96	[2] 30.00		73.0	−1.5	85	15	79	62	28	67	17	66	63	73	.77	−3.1	6	4,964	ne.	23	e.	26	14	13	3	3.9	.0	.0

[1] Observations taken hourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service*

NOVEMBER 1933

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
Cape Race, N.F	99												
Sydney, C.B.I	48												
Halifax, N.S	88												
Yarmouth, N.S	65												
Charlottetown, P.E.I	38												
Chatham, N.B	28												
Father Point, Que	20	29.81	29.84	−.12	21.3	−7.6	28.1	14.5	57	0	4.82	+1.71	43.4
Quebec, Que	296	29.56	29.90	−.12	23.3	−5.7	29.7	16.8	57	−2	4.00	+.24	26.8
Doucet, Que	1,236												
Montreal, Que	187												
Ottawa, Ont	236	29.66	29.94	−.08	24.3	−7.4	32.4	16.1	67	−1	3.42	+.88	17.2
Kingston, Ont	285	29.61	29.93	−.11	29.8	−5.2	38.1	21.5	59	4	3.43	+.19	8.7
Toronto, Ont	379	29.52	29.95	−.00	31.7	−3.9	39.0	24.4	61	6	2.90	−.24	14.7
Cochrane, Ont	930												
White River, Ont	1,244	28.57	29.95	−.03	10.5	−10.0	21.4	−.5	52	−28	2.81	+.96	23.0
London, Ont	808												
Southampton, Ont	656	29.19	29.92	−.10	30.1	−4.9	37.7	22.5	76	0	4.88	+1.18	32.0
Parry Sound, Ont	688	29.20	29.91	−.10	25.4	−6.7	33.8	17.0	66	−7	5.06	+.69	22.6
Port Arthur, Ont	644	29.24	29.97	−.03	18.2	−5.8	28.2	8.1	47	−10	2.13	+.80	20.2
Winnipeg, Man	760	29.17	30.04	.00	17.5	−.5	25.5	9.5	40	16	1.72	+.64	17.2
Minnedosa, Man	1,690	28.15	30.04	.00	18.0	+.7	26.4	9.7	42	−7	.93	−.07	6.3
Le Pas, Man	860				9.7		19.7	−.2	41	−22	2.72		27.2
Qu'Appelle, Sask	2,115	27.68	30.00	.00	23.9	+5.1	33.0	14.8	50	1	.86	−.03	6.4
Moose Jaw, Sask	1,759				28.7		37.6	19.9	52	0	.67		2.6
Swift Current, Sask	2,392	27.43	30.00	−.02	32.5	+9.3	39.9	25.1	58	3	.45	−.24	4.0
Medicine Hat, Alb	2,365	27.50	30.03	+.03	34.3	+6.9	43.5	25.1	62	0	.93	+.01	4.4
Calgary, Alb	3,540												
Banff, Alb	4,521												
Prince Albert, Sask	1,450	28.45	30.10	+.07	18.8	+3.4	28.8	8.9	46	−11	1.24	+.41	12.1
Battleford, Sask	1,592	28.26	30.07	+.05	24.3	+8.0	33.7	14.8	50	−14	.84	+.26	3.7
Edmonton, Alb	2,150												
Kamloops, B.C	1,262												
Victoria, B.C	230	30.00	30.26	+.27	45.9	+2.7	48.7	43.1	55	36	3.88	−3.09	.0
Barkerville, B.C	4,180												
Estevan Point, B.C	20												
Prince Rupert, B.C	170												
Hamilton, Ber	151												

SEVERE LOCAL STORMS, NOVEMBER 1933

[Compiled by Mary O. Souder]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Hill and Blaine Counties, Mont.	2			1		Sleet	Sleet and icy roads caused numerous traffic accidents and 1 fatality.	Official, U.S. Weather Bureau.
Havre, Mont., and vicinity	2			1		Rain and sleet	Ice formed on trees and overhead wires; woman killed in automobile accident near Lohman because sleet and ice frozen on windshield obscured vision of the driver.	Do.
Harrisburg, Pa	5-6	P.m.				Glaze	Ice accumulated on wires, trees, and shrubbery; no serious traffic difficulties experienced in the immediate vicinity of the city.	Do.
Buffalo, N.Y., and vicinity	9			1		Snow storm	Man killed when truck skidded off the road; auto and bus traffic impeded; on Lake Ontario 5 persons were rescued when a two-masted schooner went aground; depth of snow from 6 to 12 inches.	Do.
Do	11			1		do	Snow 5 inches deep; boy killed and several persons injured in traffic accidents; due to low visibility, all airplane flights at the Buffalo Airport were canceled.	Do.
Northern Great Plains southward and eastward to the eastern Lake region and Appalachian Mountains.	12					Gale and dust	Severe damage by wind, dust, and electrical discharges; loss in South Dakota alone estimated to be several million dollars. An account of this storm will appear in a later issue of the MONTHLY WEATHER REVIEW.	Do.
Illinois, almost entire State	12			1		Severe dust storm.	Storm lasted several hours; visibility affected making automobile driving hazardous; dust penetrated closely fitting doors and windows; at Belltown 1 death was the direct result when an autoist was blinded by the storm.	Do.
Des Moines, Iowa	12					Gale and dust	Atmosphere so laden with dust that at times the visibility was reduced to 50 feet; gale caused loss of life and considerable destruction of property by blowing down telephone, light, and street car poles, small buildings, fences and signs.	Do.
Minnesota, extreme southwestern and southern counties.	12					Dust, wind, and snow.	Storm assumed blizzard proportions in some northwestern counties and traffic was delayed by drifted snow; at Pipestone the sun was entirely obscured at 1 p.m.; greatest destruction by wind occurred at Tracy when a steel hangar and 2 airplanes were wrecked and other property damaged; much minor damage to property occurred over the entire State.	Do.
Bismarck, N.Dak	12	A.m.				Wind	Communication lines down; a man sustained a broken cheek bone when the high wind blew him through a fence; 3 airplanes ripped loose from their moorings and damaged at the Bismarck and Mandan airports.	Do.
South Dakota, entire State	12					Gale and dust	From sunrise to sunset high west to northwest winds, attaining gale force, swept the State, filling the air and sky with clouds of dust and dirt so dense over the eastern portion of the State that the light of an otherwise clear day was reduced to a twilight condition and the visibility at times to zero; automobile lights were necessary at mid-day; cars stalled with shorted ignition systems and high electrical charges accumulated on wire fencing making the opening and closing of wire gates a hazard; work of cleaning up after the storm was enormous; homes had to be given a thorough house cleaning and merchants had to clean each item of stock.	Do.
Wyoming, southeastern portion of State.	12					Wind	Automobile windshields were badly pitted by blowing sand; small seedling pines were stripped of bark on the windward side.	Do.
Indianapolis, Ind	12-13	10:30 p.m.-2:15 a.m.				Dust storm	Exposed surfaces were covered with a thin layer of dust and automobiles moving over paved streets left distinct tracks in the dust; pedestrians' clothes were covered with dust and grit, dust getting into eyes, mouth, and nostrils; distinct odor resembling that of a smoking oilstove accompanied the dust cloud.	Do.
Tennessee, entire State	13	8 a.m.				Severe dust and wind.	The air was thick with dust, the sun's disk was faintly visible; dust very thin by sunset and disappeared by midnight; surface visibility reduced to one half mile.	Do.
Buffalo, N.Y.	13	9 a.m.				Dust and mist	Every exposed window glass in the city became soiled with yellowish brown dust; deposit especially noticeable on automobiles.	Do.
Charleston, S.C.	13	P.m.		1		Thundersquall	2 small cargo boats capsized in harbor; man drowned while trying to swim to shore.	Do.
Buffalo, N.Y., and vicinity	14			3		Snow	Several persons injured in accidents; traffic somewhat retarded; over 6 inches of snow fell, this being the third snow storm within a week; freighter bound for Buffalo went aground 12 miles west of Long Point on Lake Erie; arrival of other freighters delayed from 6 to 14 hours.	Do.
Oxford, Ala., 5 miles south	21	6:10-6:15 p.m.	35		$2,500	Tornado	Damage to the Civilian Conservation Camp estimated to be $2,500; 9 persons injured.	Do.
Princeton, Ill.	29	P.m.	1,760		70,000	Hail	Damage principally to windows and greenhouses; path several miles long.	Do.
LATE REPORT *Oct. 11, 1933*								
Cold Springs, Okla., and vicinity.	11		[1] 8		10,000	Heavy hail	The size of hailstones varied from that of small marbles to baseballs; considerable damage, principally to unpicked cotton, reported.	Do.

[1] Miles instead of yards.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, November 1933

Chart I. Departure (°F.) of the Mean Temperature from the Normal, November 1933

Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.
Statute Miles
Kilometers

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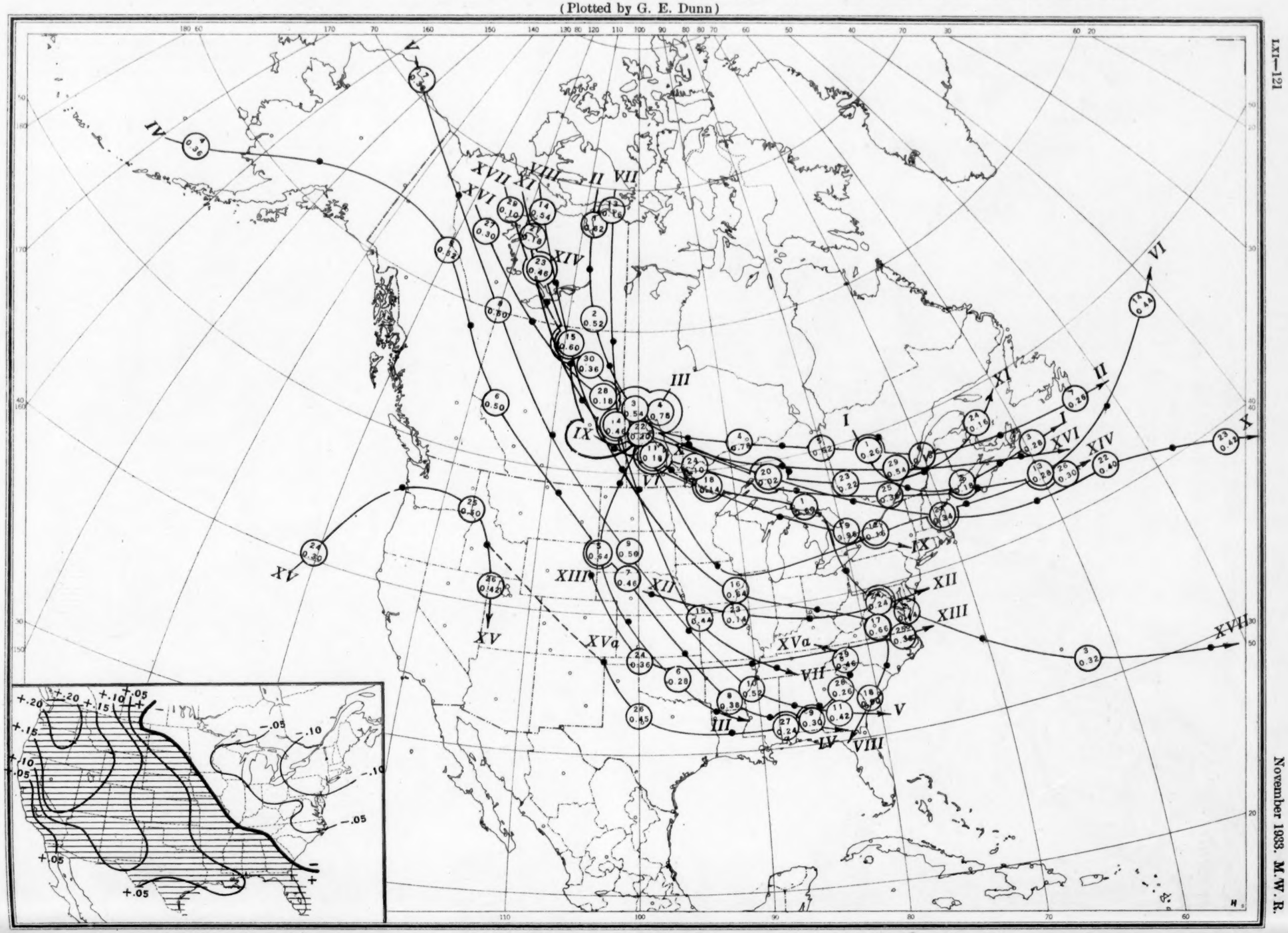
Chart II. Tracks of Centers of Anticyclones, November 1933. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by G. E. Dunn)



Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

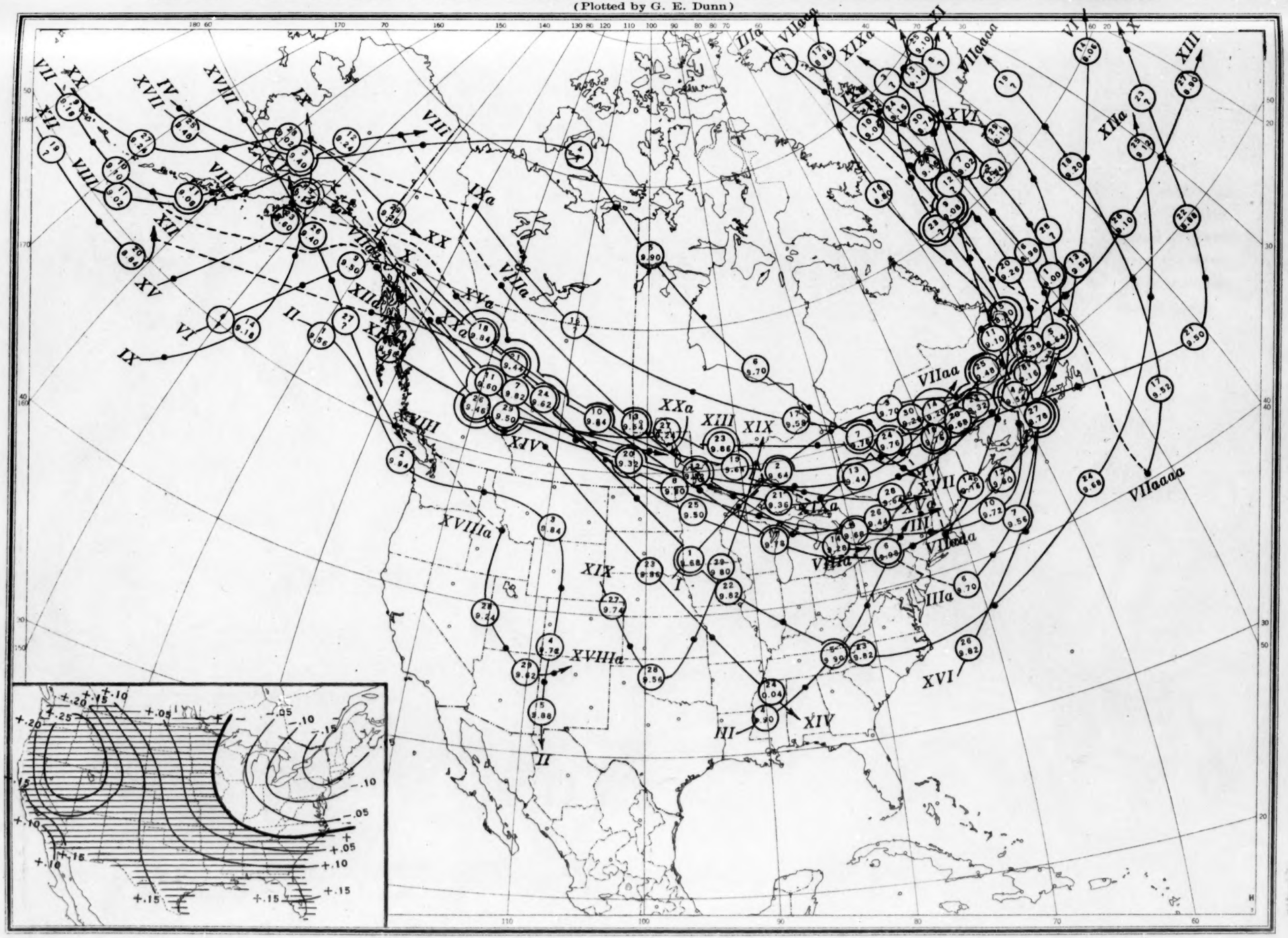
Chart III. Tracks of Centers of Cyclones, November 1933. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by G. E. Dunn)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, November 1933. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

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Chart IV. Percentage of Clear Sky between Sunrise and Sunset, November 1933

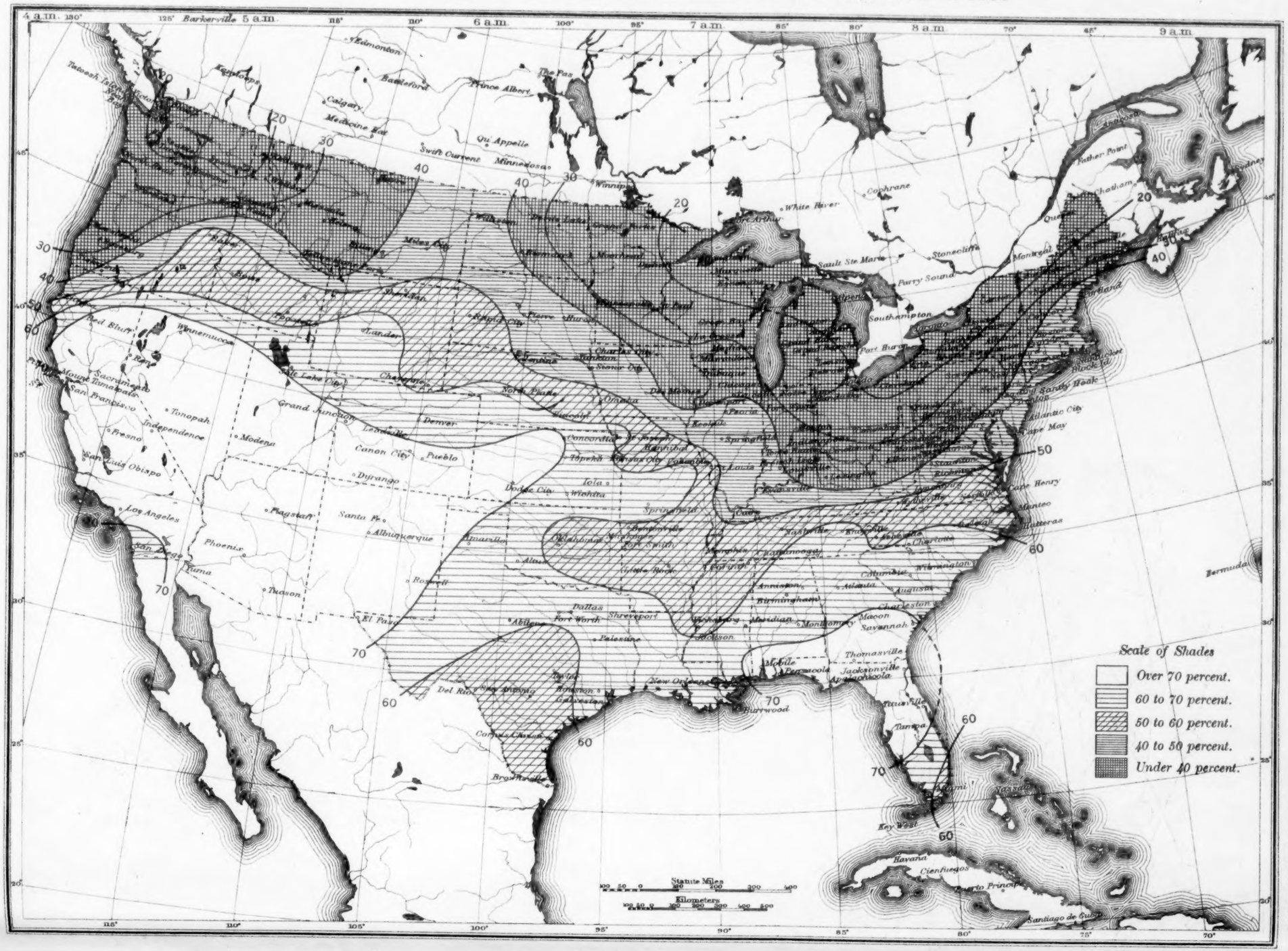

Chart V. Total Precipitation, Inches, November 1933. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, November 1933. (Inset) Departure of Precipitation from Normal

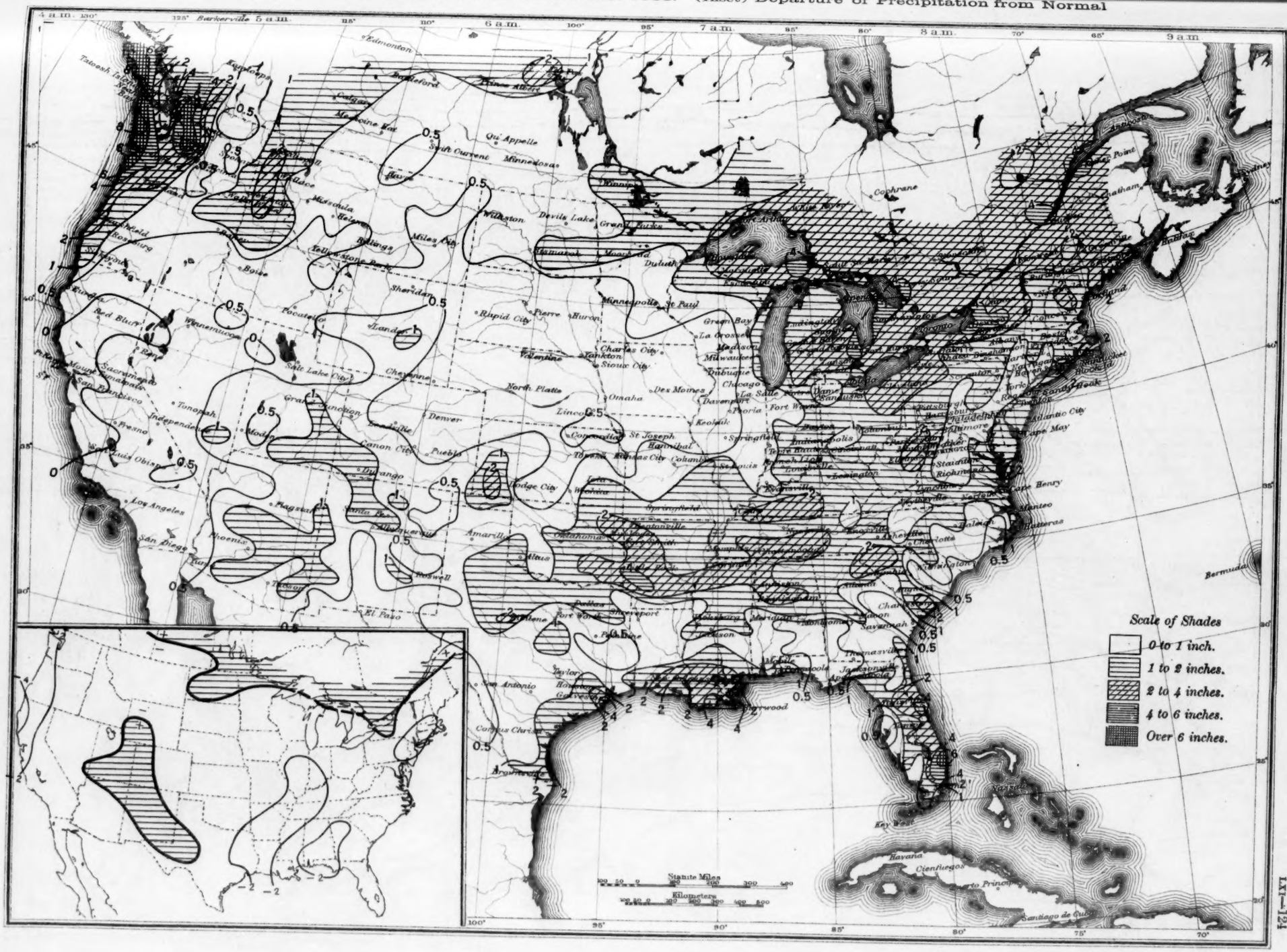

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Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, November 1933

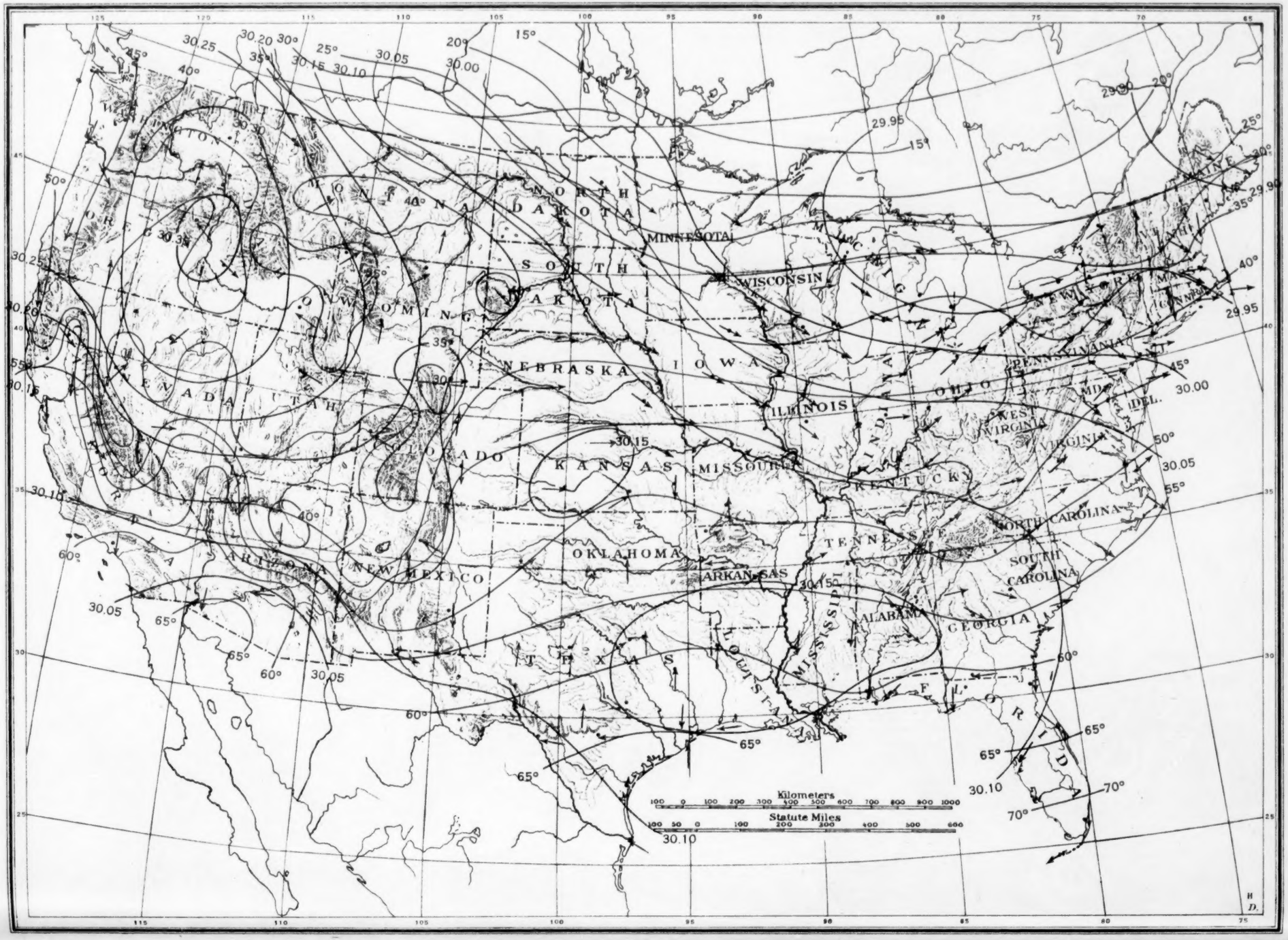

Chart VII. Total Snowfall, Inches, November 1933.

Chart VII. Total Snowfall, Inches, November 1933.

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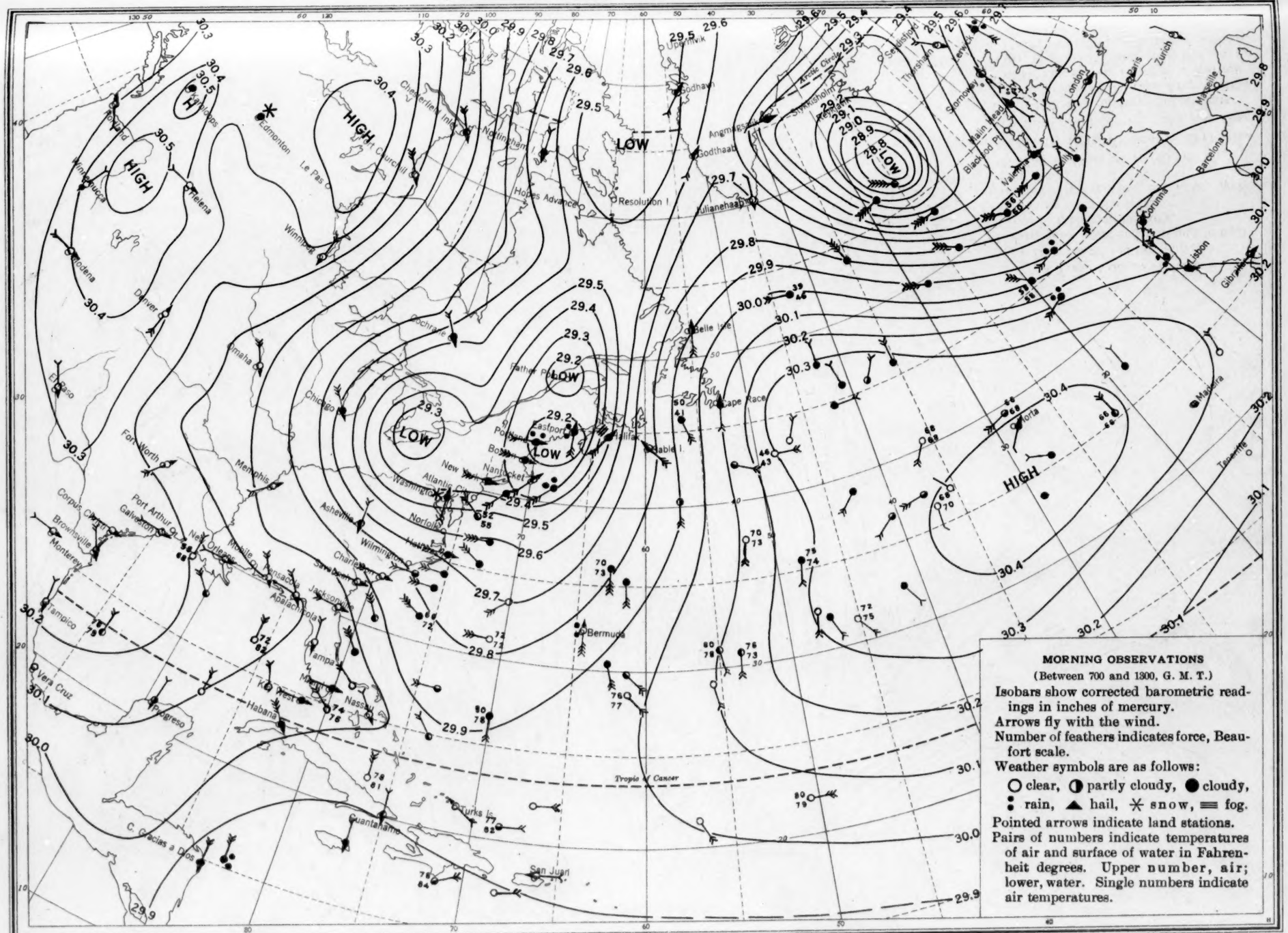
Chart VIII. Weather Map of North Atlantic Ocean, November 14, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart VIII.—Weather Map of North Atlantic Ocean, November 14, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⋮ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

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Chart IX. Weather Map of North Atlantic Ocean, November 15, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)

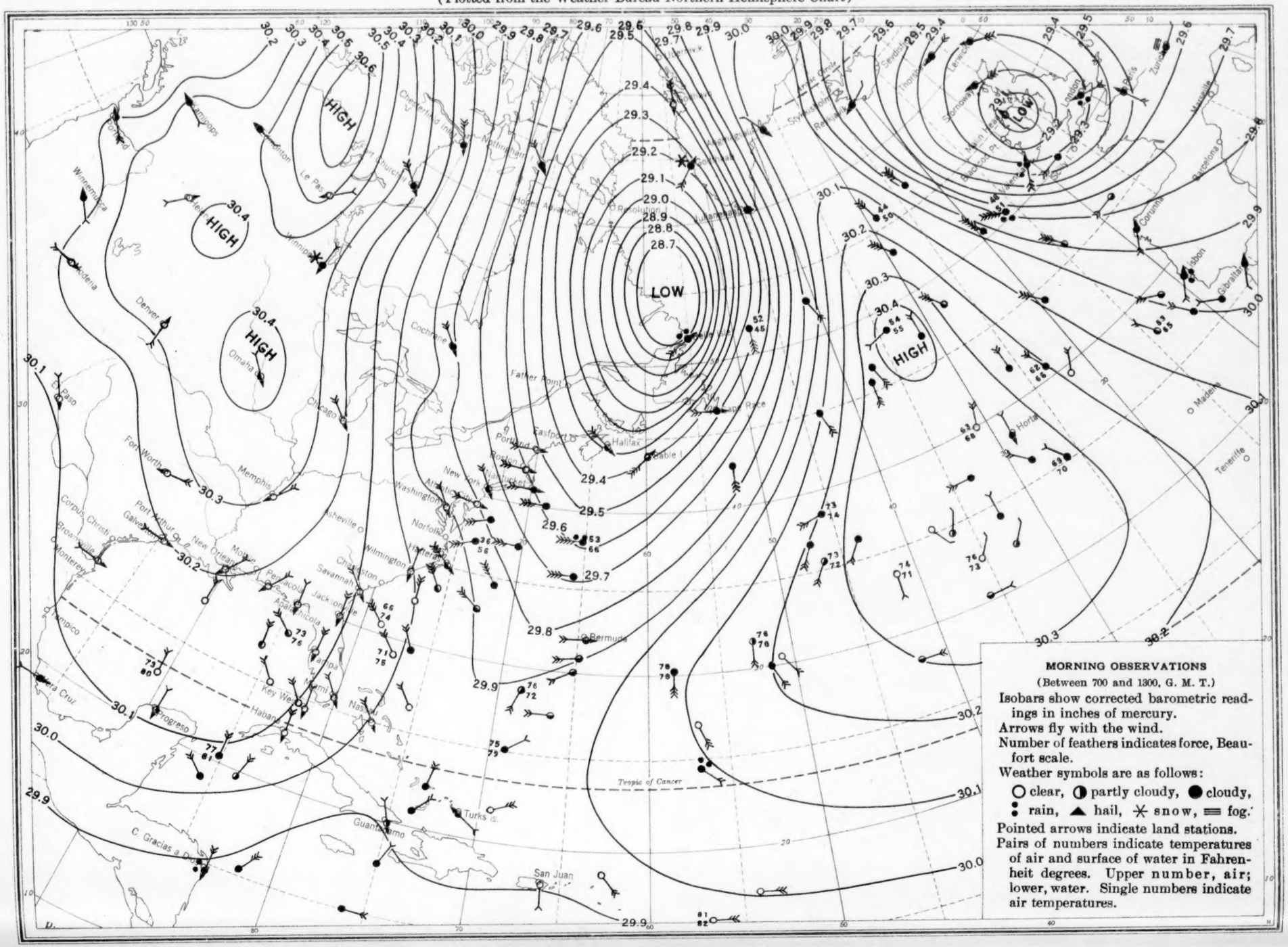
HIGH
HIGH
HIGH
HIGH
LOW
LOW
Tropic of Cancer
MORNING OBSERVATIONS
(Between 700 and 1300, G. M. T.)
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicates force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy,
rain, hail, snow, fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

Chart X. Weather Map of North Atlantic Ocean, November 16, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart X. Weather Map of North Atlantic Ocean, November 16, 1933
(Plotted from the Weather Bureau Northern Hemisphere Chart)

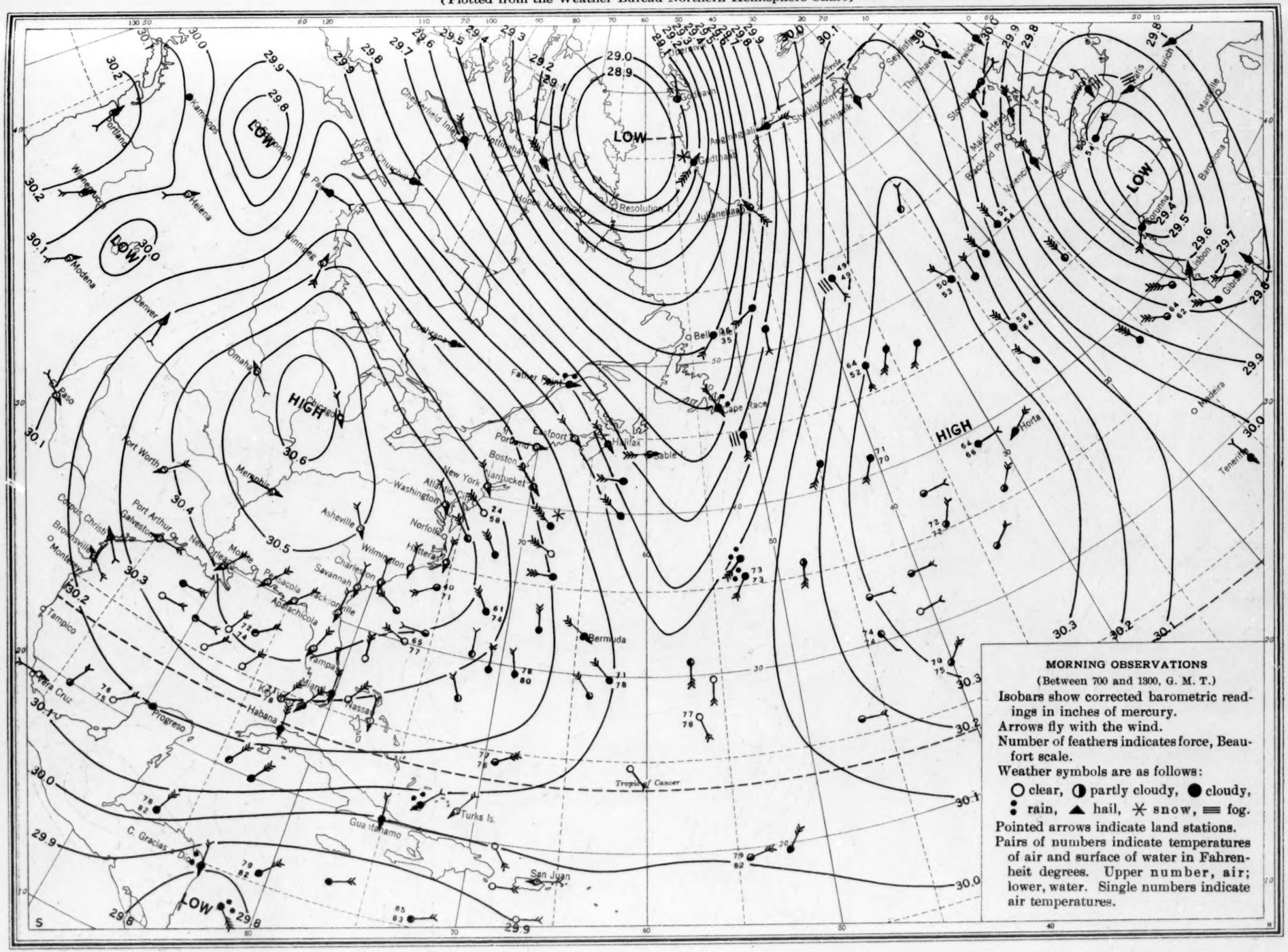

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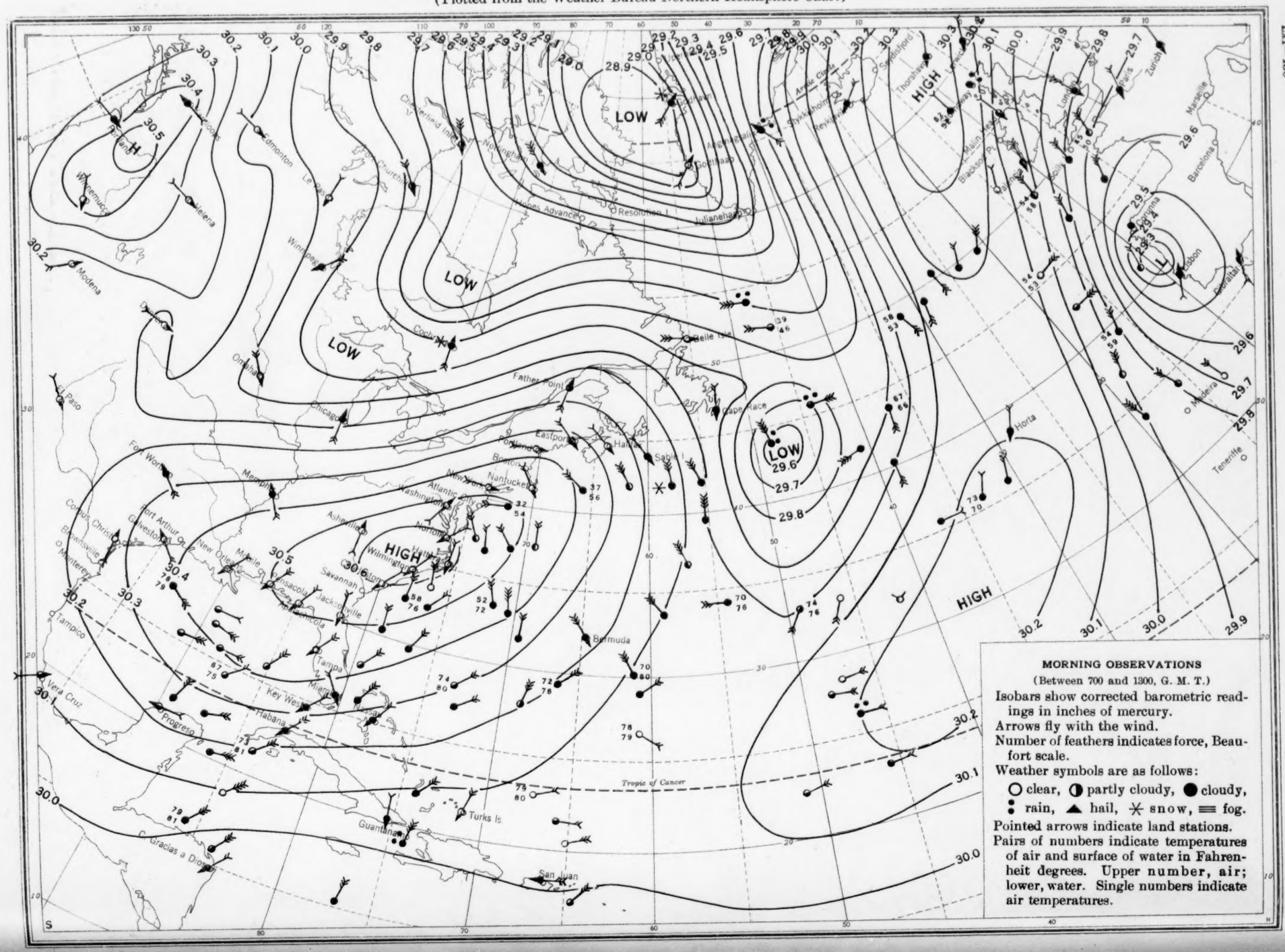
Chart XI. Weather Map of North Atlantic Ocean, November 17, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

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